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I

INVESTIGATIONS ON THE GREENLAND COD

(*GADUS CALLARIAS* L.)

WITH AN INTRODUCTION ON

THE HISTORY OF THE GREENLAND COD FISHERIES

BY

AD. S. JENSEN AND PAUL M. HANSEN

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Preface.

The materials for this report have been obtained mainly from the following expeditions to the waters of West Greenland.

The practical and scientific fisheries investigations made by the brig "Tjalfe" at the instigation of the Greenland Government in the years 1908 and 1909 under the direction of AD. S. JENSEN.

The investigation of Å. VEDEL TÅNING in 1924 for the Danish Commission for Marine Investigations (Kommissionen for Havundersøgelser); this material has been placed at our disposal through the kindness of Professor JOHS. SCHMIDT.

The 1925 investigations undertaken for the Greenland Government by the Danish Commission's vessel "Dana" under the direction of AD. S. JENSEN.

PAUL M. HANSEN's investigations for the Greenland Government by motor boat in the years 1926, 1927 and 1929.

PAUL M. HANSEN's investigations made in 1928 on the "Godthaab" Expedition.

In addition, we have learnt various important facts from other sources, both Danish and Greenlandic.

Further, we have profited by the experience made by the cod fisheries started at the instigation of the Greenland Government and developed by the Greenlanders themselves.

Special thanks are due to Mag. sc. J. R. PFAFF, who has assisted us in the age determinations of the many otoliths and scales of the Cod, and to Dr. phil. Å. VEDEL TÅNING for valuable information.

To begin with, as Introduction, a brief summary will be given of the occurrence of the Cod in Greenlandic waters as far back as is known, and of the fluctuations in the course of time.

History of the Greenland Cod Fisheries.

From the previous century we have reports of two periods when cod were abundant at Greenland. These we owe to Dr. H. RINK[1]), who rendered good service to the natural history of Greenland.

The first period fell in the years about 1820. At that time, according to what the older people reported to RINK, the cod were present in enormous quantities in the Juliane-

[1]) RINK, 1852, pp. 23—43; 1857, Bd. 2, pp. 223—226.

haab district and reached as far north as Disco Bay. Thereafter the cod were absent for a long period of years.

The second period began about the middle of last century and gave occasion to the appearance of European fishing vessels on the banks of West Greenland as well as to the investigation of the fjord, coast and bank fisheries by the Greenland Board of Commerce.

In 1845 two English vessels were fishing on the banks and caught 15,000 and 30,000 cod respectively. More vessels came in the following years, especially in 1848 and 49, but hardly more than 10 yearly, most of them from Shetland, the others from Scotland and Hull. The fishery was more profitable in 1848; the largest catch is said to have been 44,000 cod by a vessel with 26 men, fishing from June to late in August and a little into September; the others had 20—30,000 cod, except two vessels from Hull which only caught 15,000. The prohibition against fishing within the territorial waters was not observed; for example, one vessel is said to have caught over 30,000 cod in 3—4 weeks at the Kangâmiut dwelling place. Already in 1849, however, the fish had sensibly decreased in numbers, and in 1850 and 51 they became so scarce on the banks, that a profitable fishery could no longer be carried on. In 1850 only six or seven vessels were present, and in 1851 only three, one of which, from Berwick, carried 21 men and fished with long lines, but only caught 4,000 cod; the other two were from Lerwick and caught less than 10,000 each. After this the foreign nations gave up the fishing. But in 1852 Consul Nummesen of Føhr got permission to establish a fishing station in Greenland and in the same year sent out a vessel with men and materials to build houses and carry on a fishery; but the undertaking was quite unsuccessful owing to the lack of fish.

In 1845 on behalf of the Greenland Board of Commerce the cod fishery was undertaken at Holstensborg under the direction of Inspector Holbøll and gave a yield of 11,000 cod during July and August. After that the management was transferred to Thomsen, previously a merchant in Iceland, who was known for his ability and familiarity with the work. In 1847 Thomsen first investigated the fjord at Fiskenæsset, and then tried the fishery at Holstensborg with a yacht, partly on the banks, but mostly in the fjords, using a large seine to enclose and retain the cod shoals. On the whole, the year gave a good result. — The attempts were continued regularly in the winter and spring, but no cod were obtained until after June 22, when the fish appeared suddenly. Up to July 2, 2,300 cod were taken by a fishing vessel from Copenhagen, and then inside the fjord until the 2nd of September 30,000 cod. Further, the colony's yacht with 9 men caught 9,200 from July 20 onwards, whilst the Greenlanders obtained 5,000; thus altogether 46,500 for the year (1848), which was the best. — In 1849 Thomsen began at Holstensborg, but without result until early in July when cod appeared in the fjord; the fishing was then carried on until September 20, and there were plenty of fish, but the stormy weather permitted only 30 days' fishing in all, during which the crew of the vessel, 7 Danes and 2 natives, caught 14,000 cod, apart from what the Greenlanders obtained. The fish then disappeared entirely and there was nothing to do in the winter. — In the spring of 1850 Thomsen went with the vessel to Fiskenæset, but found very few cod and got shut in by the ice. It was not until May 22 that he came clear and then fished the

whole of the bank off Godthaab, but only caught a single cod. After trying one fjord, in which there should have been cod according to the Greenlanders, but in which they only got 80, they went back to Holstensborg on June 10. Not until the end of June did the fish appear and both vessels set out to catch them, sometimes in the fjords, at other times out on the banks, wherever signs of fish appeared, but the results were meagre everywhere. In August already the fjords at Holstensborg were quite empty of fish; it was then reported that the cod had appeared in a fjord at Sukkertoppen, but when THOMSEN whent there with both vessels, the fishing again was but moderate. The whole quantity for this year was only 12,450 cod, with 2,100 in addition fished by the Greenlanders. — If 1850 had been a bad year for the fishery, 1851 yielded practically nothing at all. THOMSEN tried as usual on the banks as well as in the fjords and with both vessels. Rumours went about that a shoal had appeared sometimes at one place, sometimes at another, but only for a short period in July were they fortunate enough to obtain a somewhat regular fishery in the fjords, and for this summer the catch of the vessels only amounted to a couple of thousand. That same year THOMSEN returned to Copenhagen and the fishing attempts were given up.

Thus during the period 1845—49 there was an abundance of cod in the southernmost district, Julianehaab, and the shoals extended up to Disco Bay; here during the autumn months the Greenlanders caught such enormous quantities of cod, that they even learnt to dry and preserve them for winter supplies; but after this, in 1850, the cod were practically non-existent.

For the rest of the 19th century and some years in the present we have no reports of cod abundance at Greenland, whether in the territorial waters or out on the banks. As regards the latter, we know that since 1866 and right on into the present century they have frequently been visited by American fishing schooners. An instructive report on the expeditions in the years 1866—81 is given by NEWTON P. SCUDDER[1]), who himself visited the banks in 1879 on board one of the schooners. During the period mentioned 31 fishing cruises were made from Gloucester to the Davis Straits; fishing was carried on out on the banks and along their edges in the months of July and August, and yielded generally good catches of halibut, whereas the cod were not present "in sufficient numbers to warrant their being salted". The proportion of cod to halibut was approximately as 1 to 15.

Instructive information regarding the state of affairs at the beginning of the present century was obtained from the fishing experiments undertaken on behalf of the Greenland Board of Commerce in the year 1906 by two Faeroese cutters under the direction of the shipowner NAPOLEON ANDREASEN of Thorshavn[2]). According to the plan the experiments should include not only the banks lying off the west coast of Greenland, but also the fjords. The banks off Godthaab and Sukkertoppen as well as the coastal waters and fjords at Holstensborg were fished from the 13th to the 21st of June, with the result that 3 cod altogether were taken in Kekertalik Fjord. As it thus

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[1]) SCUDDER, 1883, pp. 189—228.

[2]) ANDREASEN, 1906, pp. 270—72.

looked "as if the fish had not yet set in towards the coast and fjords", both cutters went off to Jakobshavn and fished for Greenland halibut. On the 14th of July the cutters again returned to Holstensborg and from that date until the 3rd of September tried the fishing to the south, both on the banks, at the coast and in the fjords, which were supposed to be most rich in cod. The total result obtained was about 2,000 cod, caught inside the fjords at the end of July and beginning of August; the largest catch was about 200 cod on one day, and the numbers steadily decreased until towards the end only a few specimens were obtained. NAPOLEON ANDREASEN concludes his report on this fishery with the following words: "If I were asked to express my opinion of the cod fishery at Greenland, then using the experience gained during the summer as guide, I should most emphatically endeavour to dissuade any outsider from going to Greenland with the sole object of catching cod, for he will here assuredly, like myself in many cases, be painfully disappointed. I have never at any place searched longer and more keenly after fish than here at the coast of Greenland, to be rewarded with such a poor result". This judgment has all the more weight as coming from a Faeroese well known for his ability and experience in the cod fisheries, and it appears clearly from his report that nothing was lacking in his plans or energy. Under the personal leadership of ANDREASEN the fishing was carried on unceasingly the whole time, not only from the cutters but likewise from a motor boat and four ship's boats.

It is worth noting, that all the 2,000 cod obtained were caught inside the fjords, whilst not a single cod was taken out on the banks, though all these were systematically fished in the period from July 18 to September 3, with long lines and hand lines right from Holstensborg point down to the bank off Godthaab.

With regard to any future exploitation of the cod fishery, NAPOLEON ANDREASEN gave the Board of Commerce the advice that the Greenlanders should be taught the methods of dealing with the cod to make it suitable for the markets; as he writes, the Greenlanders are always on the spot and thus in a position to take advantage of the moment if any shoals come in.

In 1908 and 1909 the Ministry of the Interior arranged for a renewed investigation of the fisheries at Greenland, this time by means of a practical, scientific expedition under the direction of the zoologist AD. S. JENSEN, with the hydrographer J. N. NIELSEN as scientific assistant[1]). At disposal was the brig "Tjalfe" of the Greenland Trading Co., provided with a 50 h. p. motor to drive the auxiliary and a trawl winch for hauling in the various fishing apparatus, as also with practical fishing gear (trawls, lines, seines etc.) for the capture of the adult fish and with scientific apparatus to determine the distribution of the fish eggs and fry, as well as the temperature and salinity of the water. In addition, a large and a small motor boat and several dories were available. The crew consisted of seamen and fishermen.

The first expedition lasted from May 3 to November 10, the second from April 14 to October 17. Together the two years' investigations embraced the west coast of Greenland from the southernmost point up to Umanak (ca. 60°—71° N. L.), including equally fjords and coastal waters, banks and deep water.

[1]) JENSEN, 1909, Nos. 2 and 5.

So far as the cod fishery is concerned, this expedition had exactly the same experience as the Faeroese. Not a single cod was taken on the sea-banks, although numerous long lines were set out at various times of the year both on the banks off Godthaab (Fylla Bank), Sukkertoppen (Little Hellefiske Bank) and Holstensborg (Great Hellefiske Bank). Nor was a single cod taken in the experiments along the edge of the banks (80—150 fathoms) or off the banks (150—240 fathoms); it was observed that in the deep water outside the banks, where positive temperatures are always present (in contrast to the condition in on the banks), halibut were found early in the summer before they migrate on to the banks with the rising temperature[1]), but as mentioned no cod were present. In the fjords on the other hand this expedition also met with cod shoals sometimes. By far the most of the cod were found in September 1908 in the fjords and sounds about the dwelling place Fiskenæsset in the south district of Godthaab; on 12 fishing days about 3,000 cod were caught here from the two ships' boats. Then a shoal of cod was found in the Frederikshaab district in a branch of the Neria Fjord, where 1,200 cod were taken by two boats between July 12 and 16, 1909. Further, about the middle of September 1909 considerable cod shoals were encountered wandering into the sounds about Eggers Island, on which lies Cape Farewell. Otherwise the captures within the fjords were restricted to a few cod here and there.

From these investigations the leader of this expedition could also advise the Greenland Administration to make arrangements for the cod to be bought and prepared for export by the Greenlanders at the places, where the expeditions had found cod in numbers worth mentioning.

From the year 1911 the buying and preparing of the cod in this manner began in Greenland, and since that time we have been able to build up a picture of the stock of cod in its fjords and along its coasts.

To begin with, the conditions for a fishery with prospective export were only present at two places, the fjords and sounds about Sarfânguak and round the Fiskenæsset; and only moderate quantities could be fished there, varying in the years 1911—16 from 18,500 to 124,500 kg. yearly. But since 1917 distinct progress has been noticeable, as the cod have appeared in greater numbers and over greater areas than previously, first of all in the district of Julianehaab and partly also in the Frederikshaab district, then in 1919 also in the region of the Godthaab Fjord and since 1922 also at several places in the district of Sukkertop. Thus gradually a number of new places were established for the purchase and treatment of the fish, and the quantities bought mounted up from 244,000 to 957,000 kg. in the years 1917—25. And the numbers of cod steadily increased, amounting in the later years to the following quantities; 1926: 2,055,000 kg.; 1927: 3,291,000 kg.; 1928: 3,680,000 kg.; 1929: 5,634,000 kg. (Fig. 1, p. 9)[2]).

These figures show clearly the enormous increase in the Greenland stock of cod during later years. Whilst previously the cod was only taken in noteworthy quantities at a few places, it has recently spread more and more and in the last year (1929) has occurred in quantities almost the whole way from the south point of the land up to Hol-

[1]) The correctness of this discovery has been fully confirmed by the observations made in later years with regard to the halibut fishery; cf. Hjort & Ruud, 1929, p. 25.

[2]) 1930: 8,160,000 kg.

stensborg (ca. 60°—67° N. L.). In 1928 and 1929 from July onwards it pushed its way in great numbers even farther north, right up to Disco Bay, where it had been a rare visitor in earlier years; in 1928 it had only reached to Hunde Ejland and Akúnâk, but in 1929 to Godhavn, Arveprinsens Ejland, Christianshaab and Ritenbenk.

The conditions had also changed in other respects. Previously the cod had generally been noticeable only in the summer and autumn months; now it has become so abundant that shoals have also been noticed in the winter in the deep water of fjords and larger expanses, and it approaches the coasts already in March—April, giving rise to a fishery and trade.

And on the sea banks, where practically no cod occurred in poor years, it has again appeared lately, so that we now have in every way the same conditions as in the middle of last century. The first notice of the presence of cod on the banks came in 1921 from information received from the ships inspector V. Thorsen of the Greenland Administration. As boatswain and later skipper he often lay at anchor on Fylla Bank in the months of July and August with the vessels of the Greenland Trading Co., taking the opportunity along with the crew to fish for cod but without getting any. Thus, in 1901 he lay on the bank with the brig "Lucinde" for several days, and fishing was carried on persistently but with no result. And in 1913 again he was with the steamer "Hans Egede" for 3 days (July 10—12) on the bank owing to dense fogs; the cod was persistently fished for and at different places on the bank, but in vain. Up to 1921 all attempts were quite unsuccessful. In that year their Majesties, the King and Queen of Denmark, undertook a voyage to Greenland with the s.s. "Island". On July 20 the "Island" anchored for a few hours on Fylla Bank to await the arrival of the navy schooner "Fylla" from Godthaab. Soon after anchoring Inspector Thorsen, who was on board the royal vessel, was asked if any fish occurred on the bank, but said there were none. Nevertheless some began to fish and soon afterwards caught two well-grown cod; but no more were taken. These captures came as a great surprise to Inspector Thorsen, as it was the first in all the years he had been trying the fishing on Fylla Bank, that cod had been caught out there. In 1922 and 1923 the Danish inspection-vessels "Fylla" and "Islands Falk" found numbers of cod on Fylla Bank in July, and in 1924 fishing experiments from the "Islands Falk" discovered cod in quantities on the Fylla Bank in June; on the banks farther north but few cod were found[1]). That same year Professor Johan Hjort, who was investigating the conditions with the Norwegian research-vessel "Michael Sars", confirmed the occurrence of cod on the Fylla and Little Hellefiske Banks in August[2]). And the 1925 cruises[3]) made by the Danish research-vessel "Dana" showed that considerable quantities of cod occurred on the Fylla Bank and the southern part of the Little Hellefiske Bank, fewer on the banks lying farther south. In the same year the Faeroese cutters began to fish on the banks; according to the Fishery Report their fishing brought in the following quantities of salt fish; 1925: 142,720 kg.; 1926: 960,000 kg.; 1927: 1,119,600 kg.; 1928: 523,000 kg.; 1929: 3,864,000 kg. To assist their fishery the Faeroese have

[1]) According to Å. Vedel Tåning, cf. Jensen, 1925, p. 38.
[2]) Hjort & Ruud, 1929, p. 16.
[3]) Jensen, 1926, pp. 91—92.

obtained a station on land, where they can have depots and work up the fish; they are not obliged either to fish outside the 3-mile limit, but can come right in to the outermost skerries. Since 1924 the Norwegian fishermen have also fished on the West Greenland banks, chiefly for the more valuable halibut, but also quantities of cod; the yield in 1926 was 300,000, in 1928 about 8—900,000 kg. of salt fish[1]). In 1928 two and in 1929

Fig. 1. Product of the cod fishery of the Greenlanders, from 1911 to 1929.

three French vessels likewise fished on the banks. — Thus, the cod has gradually spread to the northern banks, so that the Greenlanders, who carry on the halibut fishery from motor boats on the banks off Holstensborg and had never before caught cod on their long lines, have recently obtained more cod than halibut on their lines.

Experience shows, that the cod occurs every year at Greenland, but for long periods only in relatively small quantities, which keep mainly to certain fjords and sounds about

[1]) Hjort & Ruud, 1929, p 29.

Sarfânguak and Fiskenæsset. Periodically, however, the cod may appear in larger quantities, in fact in much larger quantities, and spread to the fjords and coasts where usually it hardly ever occurs, at times indeed it seems to overrun the whole coast from Cape Farewell up to Holstensborg or even farther right up to Disco Bay. In these rich years the cod may also for a time be found on the banks off the coast.

In the following sections we shall discuss our investigations into the biological conditions of the cod in Greenlandic waters; since without exact knowledge of these more important aspects a true understanding of the special features of the Greenland cod fishery can hardly be obtained.

Spawning Conditions of the Cod at Greenland.

With regard to the important question, whether Greenland has its own stock of cod, which has come into the world there and grown up there, or if the cod migrates into Greenland waters from elsewhere, the investigations of recent years have brought light upon the subject to a great extent.

It was necessary first of all to determine whether the cod spawn in the Greenland waters; this could be ascertained partly by determining whether spawning fish occurred there, partly by searching for the cod eggs and fry, which as is well known float on the surface of the water.

In 1927 the investigations began in the early days of May, and in that month cod with running spawn were found in Amerdlok Fjord at Holstensborg, to the north of Kangâmiut and at Atangmik; many cod ready to spawn were also taken in the beginning of May 1925 and 1927 in the fishing experiments at Kapisigdlit in the inner part of the Godthaab Fjord, and in 1928 already at the middle of March in Tuno (Hamborg Sound) north of Sukkertoppen.

Spawned eggs of cod were found in 1925 in the period June 6—23, floating (pelagically) in the coastal waters, over the banks and a little outside these on the stretch from 63°10′ to 66°45′ N. L., thus over a very considerable area, yet only in relatively small quantities at each station, but in large numbers (2,700 eggs in a half hour's haul with a 2 m. canvas net) in one of the innermost branches of the Godthaab Fjord, the previously mentioned Kapisigdlit[1]). In 1928 confirmation was obtained, that the eggs and tiny fry of the cod have their northern limit at the latitude noted (ca. 67 N. L.)[2]).

In 1927 many cod eggs were taken in the Holstensborg and especially the Sukker-

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[1]) A detailed account of the conditions in 1925 is given by Jensen, 1926, pp. 85—91.

[2]) The pelagic fry of two other Greenland food-fishes, Greenland Halibut (*Reinhardtius hippoglossoides*) and Norway Haddock (*Sebastes marinus*), also have their northern boundary at this latitude, whereas the fry of the Polar Cod (*Gadus saida*) are found north of this line and are distributed right up to Smith Sound; — the submarine ridge stretching right across Davis Straits, from the height of Holstensborg over to America (Cumberland), forming a natural boundary between the two spawning regions.

toppen district. Thus at one station at Pâkitsok (north of Atangmik) half an hour's haul with the 1 m. canvas net yielded 2,200 eggs on May 15, and 1,140 eggs (besides larvæ) on June 6. Cod taken in the fjords with running spawn also showed, that spawning places lie here. It is certain, however, that the cod does not spawn in noteworthy quantities in all fjords.

In later years the spawning places specially sought after seemed to lie in the fjords and coastal waters in the Sukkertoppen district on the stretch from Kangâmiut in the north to Atangmik towards the south, as also Sarkardlit in the Holstensborg district and an area in the Godthaab Fjord[1]).

It appeared from the investigations in the Sukkertoppen district that the cod must have begun to spawn in April already, as female cod were found in the beginning of May which were already spent, possibly even in the middle of March, at which period, as above mentioned, in 1928 at any rate, cod with running spawn were taken according to information received from fishmaster N. L. NIELSEN. Most of the cod certainly finish their spawning in May, but some continue into June. As the last cod eggs were taken on June 30, 1925, July 7, 1926, and July 2, 1927, it would appear that the hatching out of the eggs finishes at the beginning of July.

At the spawning time the temperature of the water near the bottom is low, at a depth of 50 m. varying at different places between + 1.73° and — 0.27° C. Near the surface, on the other hand, where the hatching out takes place, the temperature is considerably higher, 1.45°—2.75° C. at 10 m. and 2.53°—5.60° C. at the very surface, a condition that must be favourable to the development of the embryo.

Farthest south in 1928 (May 29) some few cod eggs were taken over a small bank west of Cape Farewell. In the same year (June 10) some cod eggs were taken at Ravns Storø and in 1926 some cod fry at the same place.

The distribution of the pelagic fry of the cod agrees naturally on the whole with that of the eggs. Nor was their number large out over the banks, though an exception must to some extent be made here of the southern part of Little Hellefiske Bank, for in 1925 comparatively many pelagic fry of the cod were obtained there[2]). But the pelagic cod fry occurring over the banks seem to disappear; at least they were sought for in vain in 1925 after a certain time (July 8), still far from being in the bottom stage[2]); they may have perished or moved in towards the land. Similarly, the "Islands Falk" on July 27 and 28, 1926, fished for the cod fry on the Fylla Bank but with a negative result. Most probably the young cod do not grow up on the banks at all; the young stages, earlier than the IV-group, at any rate were not found on the banks by our investigations. In the inshore waters the investigations found both the fry and eggs in greatest numbers in the Sukkertoppen district.

The first, just hatched larvae were taken already on May 1; when they escape from the egg they are about 5 mm. long. In 1927 at the beginning of June they were

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[1]) The coastal waters from Godthaab to Cape Farewell have not yet been investigated during the spawning period.

[2]) cf. JENSEN, 1926, p. 90. — In 1924 TÅNING had already taken some pelagic fry of cod, cf. JENSEN, 1925, p. 38.

on an average 7.56 mm. long, in the beginning of July 11.32 mm. and beginning of August 16.57 mm. On August 25 and September 13 the lengths of three fry were 27, 34 and 35 mm. It looks as if most of the fry change over to the bottom stage at a length of ca. 30 mm. and that the change takes place at the end of August and in September.

It is a well-known phenomenon in other waters that the tiny cod fry often live under jelly-fishes (*Cyanea* and *Aurelia*). The same holds good for Greenland; in Angmagsivik on August 7, 1926, many cod fry were observed swimming near the surface and under the many large jelly-fishes occurring there.

Of the bottom-stages of the 0-group (i. e. hatched the same year) 44 specimens were taken in a hand-net on September 15, 1927, at Kapisigdlit; they measured 49—90 mm.

It appears from the foregoing, that the cod of recent years have spawned at many places near and off the southern West Greenland, and that the growth of the fry has taken place in the coastal waters and fjords from Ravns Storø (island) to Holstensborg.

Age and Growth of the Greenland Cod.

To obtain information regarding the growth of the cod at West Greenland otolith and scale material was collected for age determinations, the length of the cod being measured from snout to the end of the caudal fin. The otoliths formed the chief material for the age determinations, as when broken across the middle they show winter and summer rings, which can easily be counted under a weak lens and thus indicate directly the age of the cod. The scales can only be used without difficulty in the case of the younger individuals; in the older specimens the ring structure on the scales is often irregular and indistinct.

The material was collected in the following years and localities;

1908: Fiskenæsset.
1909: Amitsuarssuk in Neria Fjord.
1924: Godthaab, Sukkertoppen and Fylla Bank.
1925: Fylla Bank and Little Hellefiske Bank.
1926: Districts of Sukkertoppen and Godthaab (Godthaab Fjord and Fiskenæsset) and Fylla Bank.
1927: Sukkertoppen and Godthaab Districts and Frederikshaab.
1928: Sukkertoppen, Egedesminde and Little Hellefiske Bank.
1929: Sukkertoppen and south district of Julianehaab.

In denoting the age the cod not yet 1 year old are indicated as the 0-group, between 1 and 2 years I-group, from 2 to 3 years as II-group etc.

The following tables give the results of the investigations for 1924—29. Where the material of an age-group may be considered large enough, the average lengths for each sex have been calculated in addition to the total average length for both sexes. In the case of age-groups not so well represented only the composite average has been given.

From Scheme 1 it will be seen, that the growth conditions in the Godthaab and Sukkertoppen districts are so alike that the material from these two localities might well

Scheme 1. **1924.**

Sukkertoppen (August—September).

Age-groups	II		III		IV		V		VII		VIII	
Extreme lengths in cm.	28—41		36—53		46—64		56—77		64—91		83—100	
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Number	85	89	61	68	52	66	56	58	63	72	18	
Average length of each sex in cm.	33.67	34.13	43.74	43,69	54.06	54.74	66.11	66.79	78.13	79.99	—	
Average length im cm.	33.50		43.71		54.83		66.54		79.12		89.06	

Godthaab (July—August).

Age-groups	II		III		V		VII		VIII	
Extreme lengths in cm.	25—39		36—47		58—72		68—91		68—96	
Sex	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
Number	27	23	6	10	18		95	103	11	20
Average length of each sex in cm.	31.74	32.48	42.5	40,4	—		78.47	79.94	89.91	88.40
Average length in cm.	32.08		41.19		68.89		79.24		88.94	

Godthaab, Sukkertoppen & Fylla Bank (June—September).

Age-groups	IX	X	XI	XII	XIII	XIV	XV
Extreme lengths in cm.	86—102	92—110	92—113	92—110	112—118	106—35	114—134
Number	8	4	10	24	2	15	4
Average length in cm.	94.00	104.00	104.00	102.08	116.00	117,16	121,4

be taken together. The same may be gathered from Scheme 3 of the IV-group, and from Scheme 4 of the V-group. In 1927 the Frederikshaab material has been included with the remainder with exception of the V-group.

The average lengths for the two sexes at the same age are seen to be on the whole very much the same.

In the 1924, 1926 and 1927 determinations it will be seen, that the average lengths for the same age-groups agree quite well with one another, considering the groups II to IX. For the older groups it may be remarked, that the material for the single years has been too small to yield good average figures.

The average length of the VII-group is considerably higher in 1926 and 1927 than in 1924, due to the fact that but few specimens were available in the first-mentioned

Scheme 2.

1925.

Fylla Bank & Little Hellefiske Bank (July).

Age-groups	VIII		IX	X	XI	XII	XIII		XV
Extreme lengths in cm.	69—92		83—95	85—95	99—102	97—103	94—120		106—134
Sex	♂	♀	♂+♀	♂+♀	♂+♀	♂+♀	♂	♀	♂+♀
Number	19	27	11	9	2	7	14	10	6
Average length of each sex in cm.	82.53	83.11	—	—	—	—	104.50	106.80	—
Average length in cm.	82.82		88.28	92.11	100.5	98.14	105.65		117.17

Godthaab (July).

Age-groups	III
Extreme lengths in cm.	33—52
Number	32
Average length in cm.	39.56

Scheme 3.

1926.

(June—September).

Godthaab Fjord & Fiskenæsset. **Sukkertoppen District.**

Age-groups	II	IV		III		IV	
Extreme lengths in cm.	21—32	39—60		30—49		43—66	
Sex	♂+♀	♂	♀	♂	♀	♂	♀
Number	58	54	75	32	35	67	75
Average length of each sex in cm.	—	52.30	51.73	39.19	38.89	53.13	53.19
Average length in cm.	24.22	52.02		39.04		53.16	

Godthaab & Sukkertoppen Districts.

Age-groups	V		VI	VII	VIII	IX	X	XII
Extreme lengths in cm.	60—70		73—85	83—86	82—100	87—116	106—120	102—129
Sex	♂	♀	♂+♀	♂+♀	♂+♀	♂+♀	♂+♀	♂+♀
Number	10	16	4	2	10	9	3	4
Average length of each sex in cm.	64.00	66.69	—	—	—	—	—	—
Average length in cm.	65.34		77.50	84.33	89.70	99.89	114.33	115.75

Scheme 4.

1927.
(May—September).
Sukkertoppen.

Age-groups	I	III		IV	V	
Extreme lengths in cm.	11—22	35—50		51—61	52—79	
Sex	—	♂	♀	♂+♀	♂	♀
Number	565	33	33	7	17	17
Average length of each sex in cm.	—	42.12	42.91	—	65.94	65.88
Average length in cm.	16.38	42.52		54.00	65.91	

	Kôrnok.		Frederikshaab.	
Age-groups	V		V	
Extreme lengths in cm.	55—82		57—76	
Sex	♂	♀	♂	♀
Number	41	41	20	29
Average length of each sex in cm.	65.98	66.41	62.25	66.48
Average length in cm.	66.20		64.37	

Sukkertoppen, Kôrnok, Frederikshaab.

Age-groups	VI	VII	VIII	IX	X	XI
Extreme lengths in cm.	73—85	82—89	82—94	81—108	89—113	104—114
Number	11	3	7	23	38	5
Average length in cm.	78.55	86.33	86.29	90.83	96.21	107.80

Age-groups	XII	XIII	XIV	XV	XVII
Extreme lengths in cm.	112—114	109—120	103—122	117—129	132
Number	2	2	4	2	1
Average length in cm.	113.00	114.5	113.25	123.00	132.00

years, whereas the group was very abundant in 1924. The determinations for 1926 and 1927 nevertheless lie within the limits found in 1924 for this group.

With regard to the II-group it may be remarked, that since the small specimens do not take the ordinary jig and in general do not live so near the land as to be taken in the eel-seine with the I-group, it has been difficult to obtain material which could fix its minimum size. In 1926, however, we have most probably succeeded in doing so, for

Scheme 5.

1928.

Little Hellefiske Bank (October).

Age-groups	V	VI	VIII	IX	XI	XII
Extreme lengths in cm.	71	62—89	82—92	91—96	90—104	—
Number	2	20	3	3	5	1
Average length in cm.	71.00	78.55	86.33	93.67	98.00	113.00

Egedesminde (July).

Age-groups	IV	V	VI	VII	IX	XI	XII
Extreme lengths in cm.	—	—	67—83	74—88	—	—	102—113
Number	1	1	31	8	1	1	2
Average length in cm.	59	70	75.57	81.13	80.00	103.00	107.50

Sukkertoppen (September).

Age-groups	IV	V	VI	VII	VIII	IX	X	XI	XV
Extreme lengths in cm.	53—67	58—76	62—84	70—93	83—97	91—99	91—106	88—112	—
Number	31	8	122	33	4	2	4	15	1
Average length in cm.	59.45	64.63	72.88	84.00	90.00	95.00	99.00	96.60	110.00

the II-group was numerous and could be taken with quite small jigs at several places in the area investigated.

In the 1925 material, which was collected by the s.s. "Dana" on the Fylla and Little Hellefiske Banks, only the VIII-group and the XIII-group are to some extent well represented; the younger groups were not found on the banks. Material of the III-group was collected in the coastal waters.

In 1928 only a small material was taken by the s.s. "Godthaab", as the main objective of the expedition lay north of the cod's region of distribution, and the stay in the latter was thus only of short duration.

The most complete material of that year comes from the Sukkertop and it gives a good picture of the average length of the VI-group; few specimens are present of the other groups, but the average lengths all lie within the limits determined in the four previous years. The same applies to the small material from Egedesminde, which was collected by Mag. sc. P. Kramp during his stay there.

Scheme 7 gives the collected results of the determinations in 1924, 1925, 1926, 1927 and 1928, so that we obtain from it a comprehensive summary of the cod's growth in the coastal region investigated, from Frederikshaab to Sukkertoppen as well as the Fylla Bank and Little Hellefiske Bank.

Scheme 6. **1929.**

Julianehaab Southern District (September—October).

Age-groups	III	IV	V			VI	VII		
Extreme lengths in cm.	30—43	38—55	45—65			57—72	57—91		
Sex	♂+♀	♂+♀	♂	♀	?	♂+♀	♂	♀	?
Number	11	6	44	43	21	13	121	165	93
Average length of each sex in cm.	—	—	54.05	54.05	55.38	—	73.25	73.11	71.10
Average length in cm.	36.00	50.50	54.31			65.15	72.92		

Age-groups	VIII		IX	X	XI	XII	XIII	XIV	XV	XXI
Extreme lengths in cm.	72—92		76—103	88—99	80—116	86—126	91—135	—	—	—
Sex	♂	♀	♂+♀	♂+♀	♂+♀	♂+♀	♂+♀	—	—	—
Number	7	16	14	6	9	10	5	1	1	1
Average length of each sex in cm.	82.29	84.75	—	—	—	—	—	—	—	—
Average length in cm.	83.83		90.14	94.33	98.78	106.60	111.20	109	124	153

Scheme 6 shos the determinations from the Julianehaab south district in the autumn of 1929. Comparing these with Scheme 7 we see at once, that the average lengths for all the groups III—VIII are considerably smaller than the averages for the same groups in the Godthaab and Sukkertoppen districts and Frederikshaab.

Although the material is fairly large, only the V- and VII-groups are well represented; these were indeed very prominent in the stock.

It will be seen, that these two groups in length correspond almost to the IV- and VI-groups respectively in the more northerly districts. The growth has thus been much slower.

This slow growth must be due to the hydrographical conditions here. Whilst the more northerly areas are under the influence of warm Atlantic water and usually have no pack ice in the summer (in the southern district of Godthaab only for a short time), the coast of the Julianehaab south district is washed by the Polar Current and pack ice persists here for a longer time in the summer. It is thus clear, that the biological conditions for the cod are more unfavourable here than farther north. It is uncertain, if the slow growth is due to the direct influence of the lower temperature or to its indirect action, the food possibly being more scarce from this cause.

The cod otoliths, collected in 1909 by the "Tjalfe" Expedition from Amitsuarssuk in the Neria Fjord, indicate special features which will be discussed later (pp. 19—20).

The cod otoliths from Fiskenæsset, taken by the same Expedition in 1908, show the same growth conditions as in Scheme 7.

Scheme 7.

Extreme and average lengths of the different age-groups, calculated for the Sukkertoppen District, Godthaab District and Frederikshaab.

Age-groups	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
Extreme lengths in cm.	11-22	21-41	33-53	39-67	52-82	62-89	64-93	68-100	80-116	85-120	88-114	92-129	94-120	103-135	106-134
Average length in cm...	16.38	26.22	41.85	53.75	66.09	74.29	79.61	86.43	90.92	96.56	101.08	107.28	110.08	116.74	119.72
Annual growth in cm. ca.	9.84	15.63	11.90	12.34	8.20	5.32	6.82	4.49	5.64	4.52	6.20	2.80	6.66	2.98	
Average length in cm., from HJORT's determinations in 1924	—	—	—	—	—	76	78	79.5	84	102	106	110	116	115	—

In 1924 the Norwegian research-vessel "Michael Sars" under the leadership of Professor HJORT, carried out fishery investigations in the Davis Straits. To determine the age 81 otoliths of cod were examined from the Fylla Bank and Little Hellefiske Bank. The average lengths found, given in Scheme 7, lie for all groups, except those of the VIII-group, within the limits noted in the Scheme.

The average lengths given by HJORT for the VII-, VIII- and IX- roups are lower than those given in the Scheme, whilst those for the X—XIII-groups are higher.

As will be seen, HJORT only had materials of the VI—XIV-groups, the groups occurring on the banks that year.

The yearly growth in length can also be seen from Scheme 7. It is greatest in the early years, about 10—12 cm. on an average, up to the sixth year. From this year onwards it is about 5 cm. on an average. This feature is due to the fact, that many of the cod become mature in the sixth year and from that period grow more slowly.

For the Julianehaab south district the material of several of the year groups is too incomplete to give a proper representation of the yearly growth.

Marking experiments also give a picture of the growth, when the cod are measured both on setting them free and on recapture. The average annual growth, calculated from the measurements of 18 cod, proved to be 5.2 cm.; this increase agrees well with the above-noted yearly growth of the mature cod, which was 5 cm.

It seems that but few cod reach an age of 14—15 years. On the banks, where the stock is usually composed of older age-groups than the coastal stock, the 1912 and 1910 age-groups were strongly represented in 1924 and 1925; these groups were thus 13 and 15 years old respectively in 1925. Otherwise the 14 and 15 years old cod are very rare in the catches.

It is probable that 11—12 years represent the maximum age for most cod and that the greatest mortality thus occurs at that age.

As examples of very old cod may be noted a cod taken at Sukkertoppen in 1927, which measured 152 cm. and weighed 35 kg. ungutted; its age was determined as about

21—22 years. Another large cod was caught in 1929 at Karsorssat; it measured 153 cm. and its age was placed at about 22 years. Giants such as these are fairly rare; they are often weakly, thus the large cod from Sukkertop had a very large swelling in the ovary; a giant cod taken at Sydproven had the gills covered with cysts; many are also very thin.

In 1909 the "Tjalfe" Expedition found some cod in quite a small fjord, Amitsuarssuk, about 4 miles east of Smallesund in the Frederikshaab District. This occurrence offers such peculiar features, that it merits special mention.

Amitsuarssuk is a small fjord consisting of four expanses or broads connected by narrows. Of the broads the innermost has a depth of 60—70 m., the next about 25 m. In the outermost two the depth is only about 10 m. and almost all the cod were caught in these, whilst they were few in the third and wanting in the innermost.

The narrows between the broads were of such a small depth and so narrow, that the tides raised a strong current, in the two outermost like a waterfall. The ice lying densely packed outside was prevented by the low and narrow courses from entering inside, so that the fjord was quite free of ice.

According to information obtained from the people of the district cod were to be found in this locality the whole year round, whereas at other places in the district, e. g. at Neria and Narssalik, no cod appeared at that time.

From July 11 to 16 fishing was carried on here with jigs, cod traps and eel seines and over 1,200 cod of many different sizes were taken, most between 40 and 65 cm., the largest 106 cm.

Some of the largest females had spawned, as could be seen from atrophied eggs in the ovary; this condition was found in three cod examined, in length 76, 79 and 98 cm.

All the cod taken were very thin and had very small livers; the stomachs contained chiefly Mollusca, Annelids and Amphipods, many of the larger cod had small cod in their stomachs.

Neither *Uvak* (*Gadus ogac*) nor *Cottus* was found in this locality, though both species were found in quantities in the Neria Fjord outside and in Smallesund. They had probably been exterminated by the cod. The long-rough dab was the only fish taken besides the cod.

In the few days of fishing almost the whole stock of larger cod was fished out.

Examination of the otolith material taken here revealed growth conditions quite different from those found in other localities of Greenland.

Scheme 8 shows the lengths in cm. of the cod whose ages were determined.

It will be seen, that in addition to being very irregular the growth is considerably slower than at other localities. For example, three cod of 58 cm. in length are respectively 6, 7 and 11 years old; one cod of 48 cm., equivalent to 3—4 years old at other places, is here 7 years, and a cod of 62 cm., elsewhere 5—6 years old, is here 12 years.

Many things indicate, that the Amitsuarssuk cod form a local stock which is shut off and spawns, grows up and lives its whole life within this restricted area, where the food conditions are quite unfavourable; hence the slow and uneven growth.

Scheme 8.

Age-groups											
III	IV	V	VI	VII	X	XI	XII	XIII	XIV	XV	XVI	XVIII
30	32	37	50	47	64	58	62	87	87	90	103	92
30	35	..	54	48	70	66	80	87	92	..	106	97
36	37	..	58	55	..	76	91	111	..	..	..	..
38	..	..	..	58	..	85	109	98	..	..	..	..

Age at first Maturity.

Examination of the genital organs of the cod has shown, that most reach sexual maturity at a length of about 72 cm., corresponding to an age of ca. 6—7 years. Some possibly become mature already in their 5th year, others much later, in the 7th or 8th year. The males apparently are first mature, as males with running milt were found at 64—66 cm.[1]).

Sæmundsson has found a similar age for the inception of sexual maturity among the Iceland cod [2]).

Comparison of Growth with that of the Norwegian and Icelandic Cod.

Comparing the rate of growth in the Greenland cod with that in other regions we see, that the Greenland form grows much more rapidly than the Norwegian, a fact also noted by Johan Hjort in 1924[3]).

Compared with the Iceland cod, however, the growth in the Godthaab and Sukkertoppen districts has a very great similarity to that of the Northwest Iceland cod, whilst the growth conditions in the Julianehaab district most nearly resemble those of the

Scheme 9.

Age-groups.....	I	II	III	IV	V	VI	VII	VIII	IX
Godthaab, Sukkertoppen & Frederikshaab.....	16.4	26.2	41.9	53.8	66.1	74.3	79.6	86.4	90.9
Julianehaabs S.-Distr....	—	—	36.0	50.5	54.3	65.2	72.9	83.3	90.1
N.W. Iceland.....	15.2	30.6	40.7	55.4	65.5	76.3	83.0	89.5	(98.0)
N. Iceland.....	15.0	25.4	36.9	44.6	53.1	69.8	75.6	84.4	90.2
E. Iceland.....	12.7	22.8	33.4	43.9	56.4	71.4	80.7	83.1	(84.5)
S. Iceland.....	29.0	43.8	55.9	66.1	75.6	81.6	89.8	93.6	93.9
S.W. Iceland.....	20.3	32.0	46.1	59.5	70.7	82.1	87.9	92.0	94.4
N. Norway.....	15.1	21.9	31.2	35.0	52.4	56.3	62.2	66.2	73.9

[1]) This was the condition in 1924; from examinations in 1929 and 1930 it, however, appeared that most cod of the 1922 age -group (VII- and VIII-groups respectively) were not sexually mature. Thus it seems that many cod do not reach sexual maturity until after their 8th year.

[2]) Sæmundsson, 1923, p. 30.

[3]) Hjort & Ruud, 1929, pp. 111—12.

North Iceland cod. In West and South Iceland the growth is considerably greater than at Greenland, but in East Iceland it is lower.

To render these conditions more conspicuous we give in Scheme 9 the average lengths of the Greenland cod from the localities mentioned along with the average length from the various Icelandic regions (from SÆMUNDSSON[1])) and Northern Norway

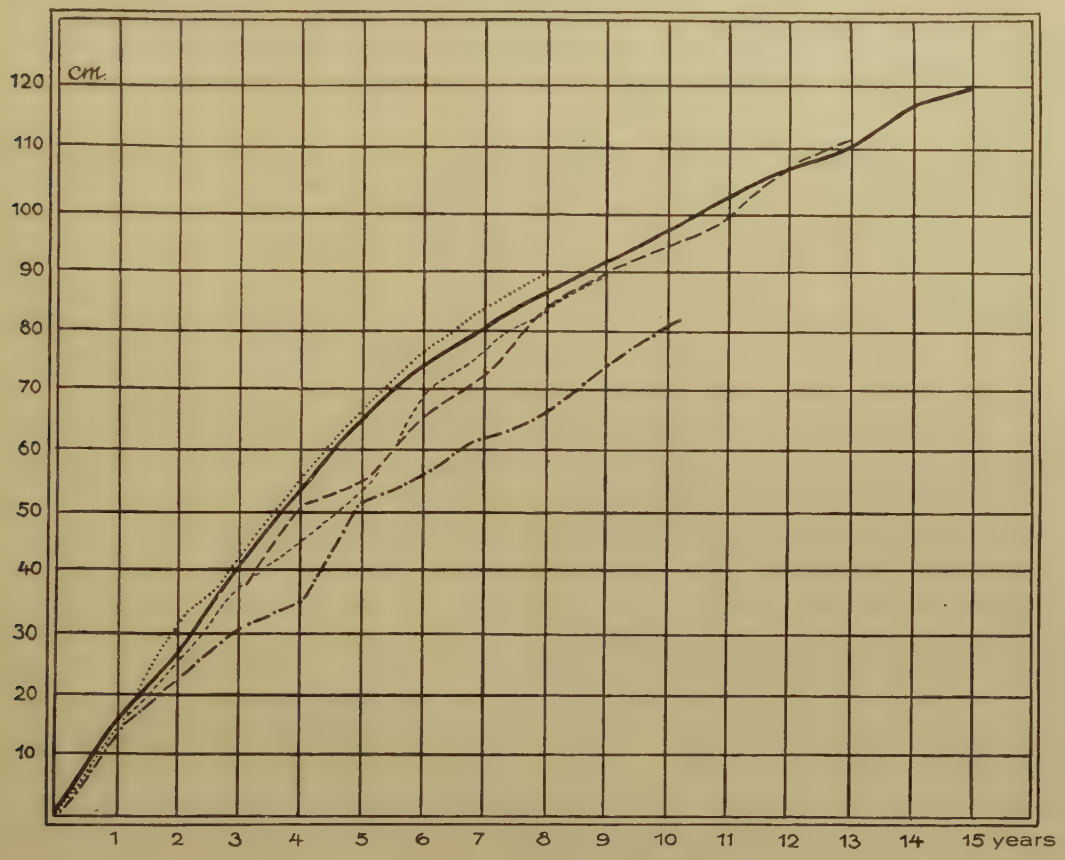

Fig. 2. Growth curves of the cod from Greenland, North and Northwest Iceland, and North Norway.
——— Sukkertoppen, Godthaab and Frederikshaab. ..... Northwest Iceland.
– – – – Julianehaab (southern part). --------- North Iceland. ·—·—·— North Norway.

(HJORT)[2]). Further, the rates of growth for most of the localities mentioned have been plotted out in curves (Fig. 2); these show perhaps even more distinctly than the Scheme the mentioned resemblances and differences.

The explanation of these phenomena is that the hydrographical conditions are to some extent the same at Middle Greenland and N.W. Iceland. At both places namely

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[1]) SÆMUNDSSON, 1923, p. 27.
[2]) HJORT, 1914, p. 143.

the coast comes under the influence of warm Atlantic water. Similarly there is a resemblance between N. Iceland and southernmost Greenland, as both regions are to some extent washed by a cold current.

Fluctuations in the Composition of the Cod Stock.

In addition to information on the growth the otolith material, in conjunction with the length measurements at the different localities, gives a picture of the conditions with regard to the distribution of the various age-groups in the Greenland stock of cod.

In other parts of the world where a fishery for cod or other fishes, such as haddock, herring, plaice etc. is carried on, it has been observed that the product of the fishery depends upon fluctuations in the stock, good or bad years for the thriving of the fry causing respectively rich or poor year-classes. In a few specially favourable years there may be a very strong growth of fry, which after some years when the fish have reached a sufficient size, may play a very great part in the fishery. The year 1904 was such a special year, which for a long time had a great influence on the cod and haddock fisheries, as also on the herring fishery.

Just as at other places we also see at Greenland, that quite specially favourable fry-years may occur, whilst in other years but a small production of fry takes place.

During the period when the cod was scarce at Greenland we have only the measurements of the cod taken by the "Tjalfe" Expedition at the Fiskenæsset in **1908**. These measurements (of about 1500 cod) are here shown in the form of a curve, Fig. 3, which has a distinct maximum and is of such a form, that one can apparently only speak of a single age-group with the extreme limits 52—78 cm. The average of the measurements is 63.93 cm. It will be seen, that both the extreme limits and the average correspond well with what was found in Scheme 7 for the V-group. This group has thus been dominant at the Fiskenæsset in 1908 and the great majority of the catch consisted therefore of the 1903-group.

From the period 1909—1923 we only have observations from Frederikshaab, where measurements and weights taken by the colonial Governor Ibsen in **1917** indicate a dominance of the 1912 year-group.

Not until **1924**, when the cod were numerous at Greenland, have we a large material of otoliths and measurements taken by Vedel Tåning, who in that year sailed along the coast with the "Islands Falk". From both the otoliths and the measurements it is clearly seen, that the VII-group (the 1917 age-group) was specially dominant, the IV- and V-groups (from 1920 and 1919) are almost equally represented, whilst the VI-group (from 1918) is extremely small.

The measurements for this and the following years are given in Fig. 4 for the age-groups appearing in the catches with jig and hand lines (see p. 25). The early classes, only taken with small jigs and eel-seine, cannot be compared directly in a quantitative manner with the older groups. It is nevertheless always possible to form an approximate estimate of their strength.

The II-group of the small cod was extremely large; the waters along the coast were dense with these small fish in 1924.

From the rich occurrence of the VII-group we see, that 1917 has been a favourable year for the growth of the cod fry, likewise 1922 (hatching year of the II-group), whilst 1918 has been a very bad year (hatching year of the VI-group). 1919, 1920 and 1921 appear to have been equally good, none of them strikingly rich.

The cod fished on the Fylla Bank in 1924 is represented by 41 otoliths. From

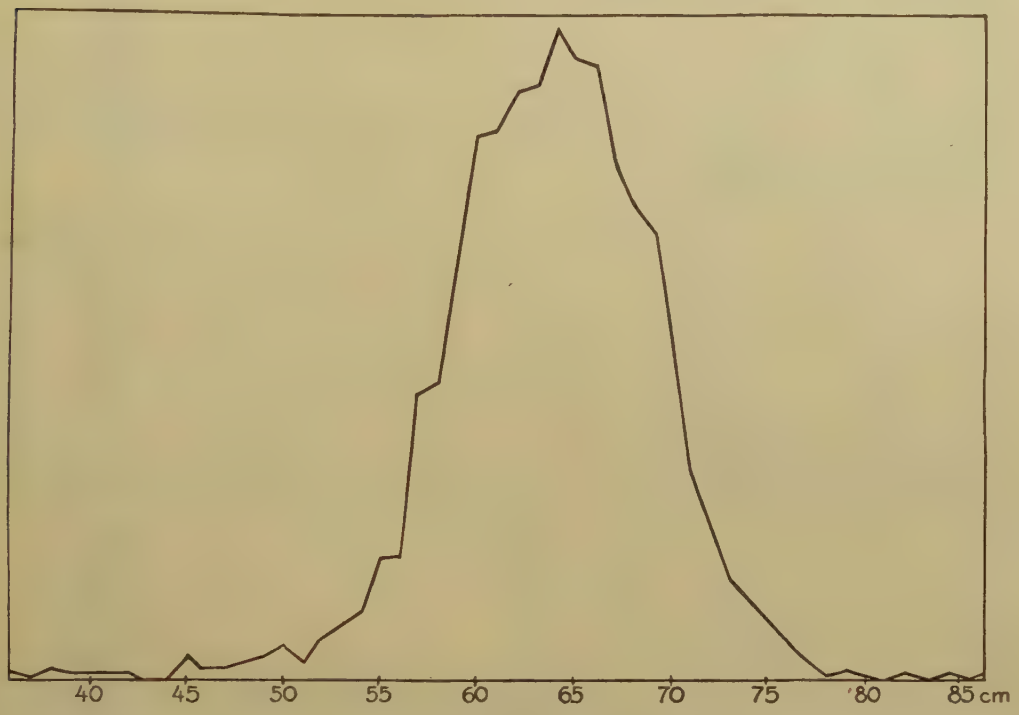

Fig. 3. Measurements of cod from Fiskenæsset in 1908. The horizontal axis shows the length of the cod in cm. The curve has its maximum at 64 cm.

such a small material one must naturally be careful about drawing far-reaching conclusions regarding the quantitative proportions of the age-classes on the banks. Scheme 10 indicates the procentual quantities of the age-groups in the material. The XII-group appears to have been specially abundant. The year 1912 must therefore have been a good spawning year. The 1917 group, which was so strong at the coast, is not specially large on the bank.

Johan Hjort, who made investigations on the bank in the same year, arrived at the same result from his material with regard to the 1912 group; his determinations are given below in Scheme 10 along with Tåning's material from the Fylla Bank.

The 1924 material from the bank differs considerably from the same year's material from the coast (cf. Fig. 4). In the coast material the VII-group (1917) is strongly

Scheme 10.

Age groups.....	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV
Year	1918	1917	1916	1915	1914	1913	1912	1911	1910	1909
TÅNING's material...	—	12.2	12.2	9.76	4.87	12.2	29.27	2.43	17.07	—
HJORT's material....	1.2	3.7	8.6	6.2	3.7	22.2	31.0	14.8	7.4	1.2

dominant, and the XII-group (1912) is not numerous, whilst the VII-group in the bank material is far exceeded in quantity by the strong XII-group. The next largest group on the Bank is the XIV-group (from 1910), and after it come the VII-, VIII- and XI-groups (from 1917, 1916 and 1913), which are almost equally large. The XIII- and VI-groups (1911 and 1918) are unimportant.

In **1925** the investigations on the banks (cf. Fig. 4) show a marked dominance of the VIII-group (from 1917); there has thus been a strong migration of the cod out from the coast to the banks, the 1917 group (the large VII-group of the previous year) being dominant at the coast the year before. The XIII-group (from 1912) is the next largest, as might be expected, the XII-group being so great on the Bank in 1924.

Neither in 1924 nor in 1925 were cod younger than the V-group found on the Bank.

At Godthaab quite a number of small cod were obtained from the coastal waters. They proved to belong to the III-group (from 1922), and it was reported that many of this size were caught; they were the smallest sizes the Greenlanders could obtain that year. It thus appears that there have not been fairly many of the II-group, whilst the III-group (the abundant II-group of the previous year) has been numerous.

Both at Sukkertoppen and Godthaab many specimens of the I-group (from 1924) were caught in the eel-seine.

In **1926** the IV-group (from 1922) had become so large that it could be caught with the jig; it proved to be so extremely abundant that it was almost the only one in the catches. The coastal waters everywhere in the districts of Sukkertoppen and Godthaab were swarming with these smaller fish. Among the older the 1917 and 1918 year-groups could be traced (see Fig. 4).

That the IV-group (from 1922) was also numerous at Frederikshaab and Julianehaab appears from the following information:

In 1926 as early as the middle of May shoals of small cod were present in Frederikshaab (10—12 inches from gill-slit to root of tail). They formed a good substitute for the capelan which remained absent.

Similarly, already in April 1926 large quantities appeared in the fjords of the Julianehaab District and persisted in the fishing in large quantities throughout the summer; dried they replaced here also the capelan, likewise absent in this district.

The length 10—12 inches from gill opening to root of tail corresponds to a total length in the cod of about 46—55 cm., which agrees excellently with the length of the IV-group.

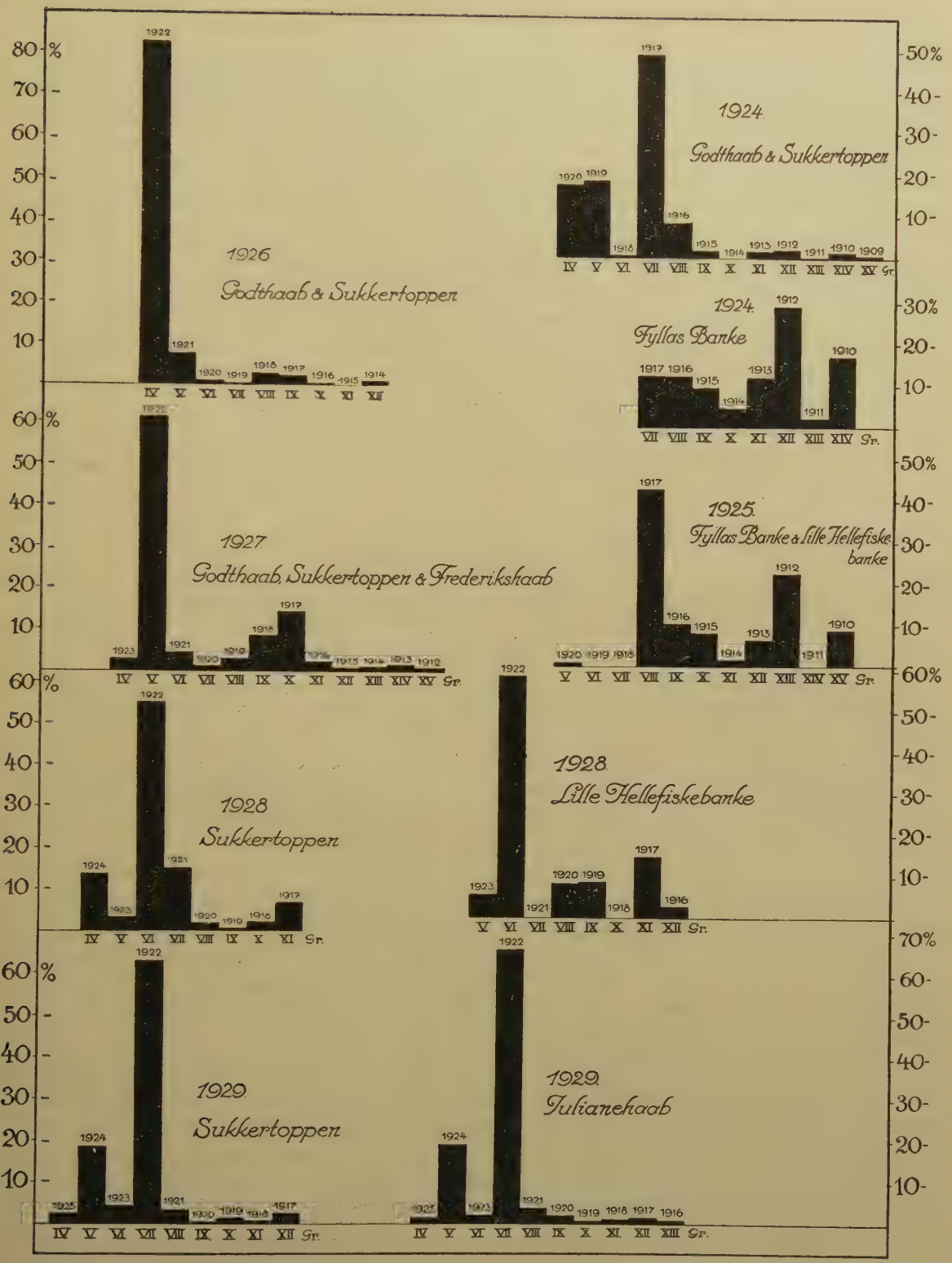

Fig. 4. The procentual quantitative proportions of the different year-groups in the catches in the years 1924 to 1929.

The 1922 group was also spread out over the Bank. The fishing experiments made by the s.s. "Islands Falk" on July 28 and 30, 1926, took but few otoliths for examination, but a number of cod were measured, marked and liberated. Medium-sized cod were not caught, only small and very large. The measurements are shown in the curve (Fig. 5, lowermost), which clearly indicates the condition. Otoliths of some of the small cod, which had been damaged and thus could not be marked, showed that they belonged to the IV-group.

The Faeroese skipper ANDREASEN, who fished on the Fylla Bank that year with his cutter "Knørrur", has given the following information:—

In the beginning of June a cutter took very large cod on the Bank; these were very thin, however; early in July the small cod began to wander out on to the Bank,

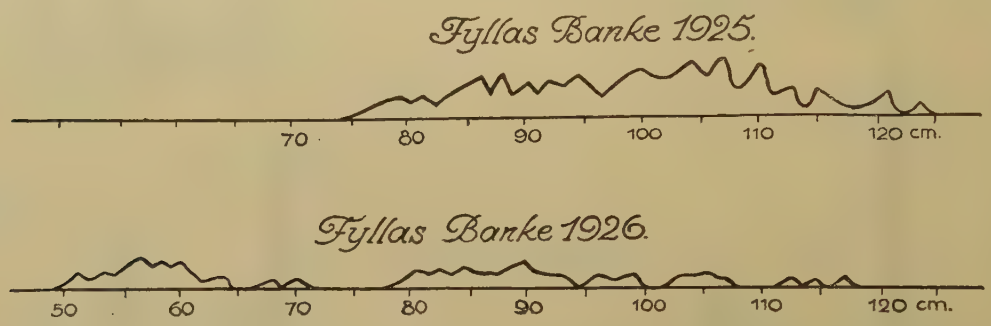

Fig. 5. Measurements shown in curves of the cod taken on the Fylla Bank in 1925 and 1926.

but unfortunately they were too small to be of any value to the fishermen, though they were fat; their stomachs were full of capelan; the fishery was thus somewhat unsatisfactory.

Among the quite small fish at the coast a fairly strong II-group (from 1924) could be distinguished, whilst neither the III-group (from 1923) nor the I-group (from 1925) appeared to be specially numerous.

As might be expected, the **1927** catches were marked by the strong 1922 group (the V-group in 1927). This is seen not only in Fig. 4 but also in the measurements expressed in curves from Godthaab, Kornok, Frederikshaab, Fiskenæsset and Sukkertoppen (Fig. 6), which show great uniformity with a distinct maximum lying at the same length. Age determinations show, that the V-group composes ca. 61 per cent. of the catches. The IV-group (from 1923) is very small, whilst the X-group (from 1917) is the next largest with ca. 14 per cent. (see Fig. 4).

Among the younger age-groups the III-group (from 1924) proved to be very well represented, and in the eel-seine numerous small cod of the I-group were taken; this was observed in large shoals along the coast everywhere in the Sukkertoppen, Godthaab and Frederikshaab districts. Probably a new and large year-group (1926) was thus growing up.

In **1928**, with material from Egedesminde, Sukkertoppen and Little Hellefiske Bank, the 1922 group (now the VI-group) also plays a very important part; about 55 per cent.

of the coastal catches and 59 per cent. on the Bank are composed of this group. The results for Sukkertoppen and Little Hellefiske Bank are shown in Fig. 4.

Among the old fish we can still detect the 1917-group (XI) with ca. 7 per cent. at the coast and ca. 15 per cent. on the Bank. The 1924-group (IV) makes up ca. 14 per cent. of the Sukkertop material examined, but certainly forms a much larger part of the whole stock. Many of this group namely are undersized fish which do not enter into the catches of the Greenlanders. This group was not caught on the Bank.

Of the smallest groups some specimens were taken of the II-group (from 1926) and according to information received this group was very abundant at Sukkertoppen.

In **1929** a material consisting of otoliths and measurements collected by fishmaster N. L. Nielsen in Sukkertoppen was sent to us; most of the otolith material was from the cut-off heads of cod taken by the Greenlanders; from the age determinations of such a material one may obtain a fairish picture of the procentual proportions of the different age-groups in the catches. The determinations (cf. Fig. 4) show a predominance of the VII-group (from 1922) with ca. 63 per cent. of the catch, whilst the V-group (from 1924) formed ca. 19 per cent.; the IV- (1925) and VI- (1923) groups were very weakly represented.

Regarding the earlier year-groups it will be seen from the measurement curve (Fig. 7), that the III-group (1926) is well represented.

In the south district of Julianehaab quite similar conditions were found as at Sukkertoppen in the same year (cf. Fig. 4).

The VII- (1922) group was also very pronounced here with almost the same percentage, namely ca. 66 per cent., of the catch; next comes here also the V- (1924) group with ca. 19 per cent. as at Sukkertoppen. The III-group was present in rather great numbers, but the II- (1927) group was scarce. Regarding the I-group nothing can be said with certainty; only at one place was it taken in quantities, namely at Lichtenau. According to information received from Julianehaab it appears that this group was numerous there in July. It was not taken in the sounds at Cape Farewell or at Nanortalik in spite of the fact, that many hauls with the eel-seine were made at these localities.

In Fig. 8 the light continuous curve represents the catch of the motorboat "Otho Fabricius" with long and hand lines, the heavy continuous curve the measurements made at the fishing station Karsorssat, whilst the three broken curves indicate the various age-groups determined from the otoliths. The whole material comes from the south district of Julianehaab in 1929.

It will be seen that the V- and VII-groups (from 1924 and 1922) are very large, whilst the VI- (1923) group is very small. Fig. 8 shows clearly further, that the catch at the fishing station consists almost exclusively of the VII-group. The reason for the non-appearance of the V-group in the catch of the fishing station is, that it lies under the minimum size for the saleable fish; as shown before, the growth in this district is considerably slower than farther north. Thus the average length of the V-group is not more than that of the IV-group at Sukkertoppen.

The cod stock of the Julianehaab District has the same composition of year-groups as the stock farther north (cf. Fig. 4), but the growth here is different.

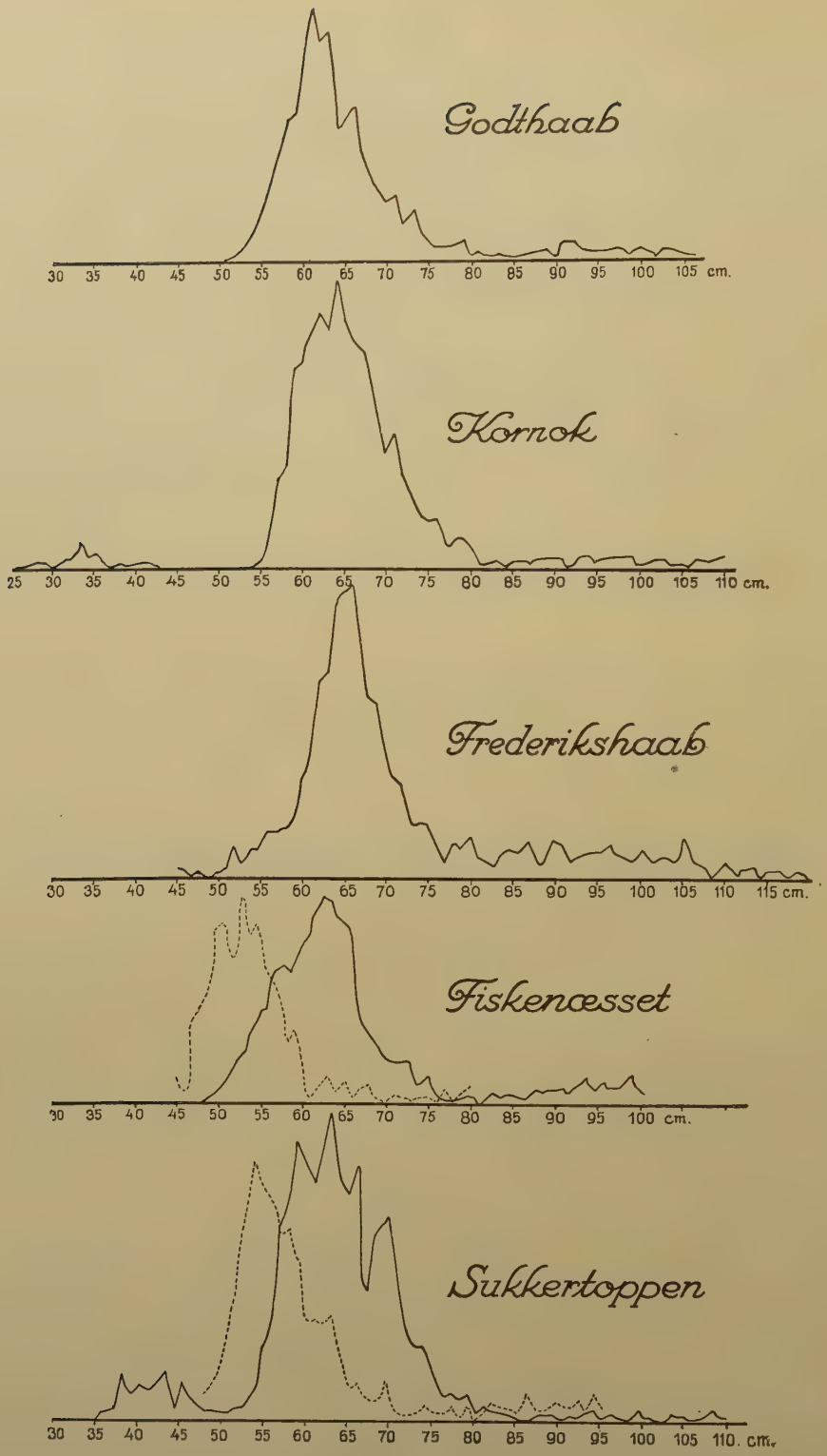

Fig. 6. Measurements of cod at various fishing places in 1927. The dotted curves represent measurements, made in 1926. It will be seen for Fiskenæsset and Sukkertoppen, how the curve has moved to the right from 1926 to 1927, almost 10 cm. at the maximum. The curves from the different localities are seen to be much alike with the maximum at the same length. At all places it is the V-group (from 1922) which is dominant in 1927. The same group dominates as the IV-group in 1926 at Fiskenæsset and Sukkertoppen.

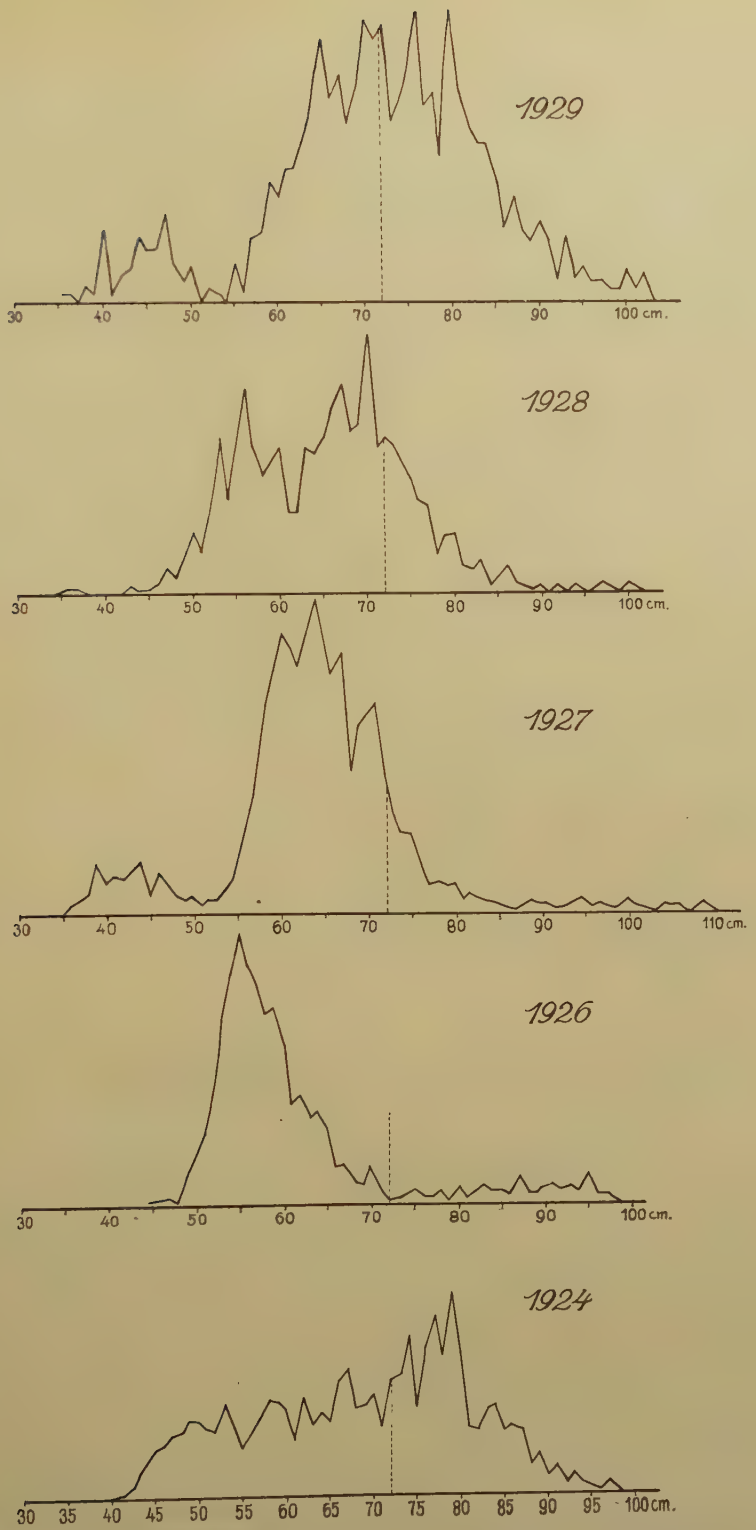

Fig. 7. Measurements of cod caught by jig at Sukkertoppen in the years 1924 and 1926—29. The dotted vertical line marks off approximately the mature cod (to the right) from the immature (to the left). The same (1922) group dominates from 1926 to 1929. A new year's group appears in 1927)the 1924-group); in 1928 and 1929 it enters into the catches along with the 1922-group. In 1929 another new group (from 1926) appears (cf. Fig. 4).

It appears from the investigations, that very great fluctuations occur in the age-group composition of the Greenland cod-stock. This might have been expected as the cod is here at its northern limit. Some years offer specially favourable conditions for the thriving of the young, and the fry of such years are then noticed in the fishery about 4 years later as many small cod, most of which fall below the minimum size of the saleable fish. In the fifth year, however, they are almost all of use for salting. Specially good fishing years may therefore be expected five years after a good fry-year.

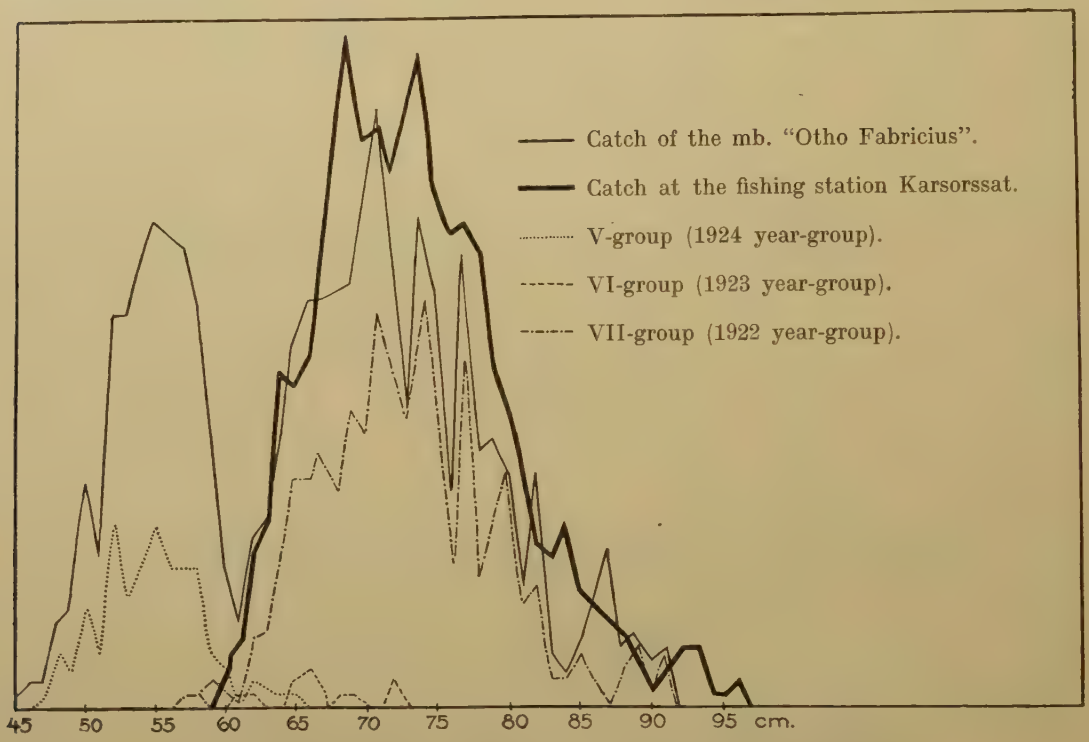

Fig. 8. South district of Julianehaab 1929 (Sept.-Oct.). (See text).

The year 1912 seems to have been a good fry-year, as this year-group occurred abundantly on the banks as late as 1924 and 1925, as XII- and XIII-groups respectively (cf. Fig. 4). That the cod fishery made a great jump in 1917 is probably also due to this fact. Possibly the 1910 year-group has also been numerous; it occurred on the banks in quite appreciable quantities in 1924, and again in 1925 it was still to be found.

The next specially rich year-group is that of 1917, which as the VII-group was found to dominate the catches in 1924, and even in 1929 it can still be detected prominently among the older year-groups.

As a favourable fry-year, however, 1922 far exceeds 1917. In the last four years this group formed more than half, in 1926 indeed 82 per cent. of the catches at the coast. In 1926 already (thus as IV-group) this group spread right out to the banks, to the chagrin of the Faeroese fishermen, who had no use for such small fish.

In more recent years the 1924 group has also had a favourable growth[1]); in 1929 already it played an important part in the fishery at Sukkertoppen and probably also at Godthaab, Holstensborg and Frederikshaab, whereas in the south district of Julianehaab this group was too small to enter into the fishery owing to the growth conditions prevailing there.

The year 1926 has also apparently been a good one, as the fishery in 1931 will presumably discover.

The year 1928 has possibly been a good year. The material, however, is too meagre to permit anything definite to be said about it. Of specially unfavourable years we have recently had 1925 and 1923. Further, 1918, 1915, 1914 and 1911 appear to have been unfavourable fry-years; whilst 1921, 1920, 1919 and 1916 have probably been somewhat better, though one is unable to say that they have been specially good. These features appear with distinctness in Fig. 4.

It will be seen from the curves Fig. 7, that the summer fishery of the Greenlanders at the coast in 1926, 1927 and 1928 has been based mainly on the immature cod; in 1929 again about half the catch consisted of mature cod. The catch on the banks in 1924, 1925 and 1928 has been made up exclusively of mature cod; in 1926 the large IV-group also spread out on the bank and led to the capture of small, immature fish. In 1927 a large part of the stock here must also have consisted of immature fish.

The catches made by the Greenlanders during the spawning time of the cod at Sarkardlit and Kapisigdlit (two important spawning places for the cod), are mainly large mature fish. Measurements of the catches in cod nets at Sarkardlit May 25, 1927, show, that the mature cod amounted to ca. 70 per cent. of the catches. Such measurements have not been made at Kapisigdlit in the spawning time, but according to information received from the fishmaster Jensen and the Greenlanders, who were fishing with cod nets at that time, the catches mainly consist of large cod.

The future prospects of the fishery are apparently rather favourable, unless unforeseen changes in the marine currents and temperature conditions fatal to the cod occur. That such catastrophes happen, cannot be completely denied; in the middle of last century the cod disappeared very suddenly after a series of rich years (cf. pp. 4—5)[2]).

[1]) It is interesting that both 1922 and 1924 were good fry-years also at Iceland (cf. Tåning, 1929, p. 85). It might thus appear as if the factors, which determine the rich fry-years, are not of a purely local character. On the other hand, the Norwegian conditions were quite different; there the 1919 year-group dominated, the years 1922—25 being weakly represented (cf. Sund, 1928, No. 1, p. 10, and 1929, No. 11, p. 83).

[2]) A similar occurrence has been noted in quite a different region. In 1873 some Norwegian sealers observed by chance that large quantities of cod occurred at Spitzbergen; this induced 3 fishing vessels to go up there in 1874 and these returned with 37,500 cod. From then onwards there was a general participation from Norway in this fishery on the west coast of Spitzbergen up to and including 1882, and the catches landed yearly in Tromsø and Hammerfest alone lay between 147,000 and 595,000 cod. But in 1883 all the boats returned empty, the total catch was 3 cod — the Spitzbergen fishery period had come to an end. A detailed report on this brief cod fishery is given by Thor Iversen (1923, pp. 115—129).

Such an abrupt vanishing of the cod may however also be explained by assuming that some time previously the spawning years conditions have been unfavourable to the fry, so that no great recruiting of the stock has taken place; thus for several years the fishing may have been based on the same year groups, which according to experience quite suddenly, when they have reached a certain age (ca. 12—13 years), become so diminished in numbers, that they play no part in the coastal fishery.

The strong 1922-group, according to what has been seen in the case of similar rich year-groups, e. g. 1912 and 1917-groups, will persist in numbers in the stock until ca. 1933—34. It will assuredly persist longest on the banks. Then come the 1924 and 1926-groups, but their magnitude will only be ascertained quite clearly after the 1930 investigations. It is nevertheless probable that a good fishery will persist at any rate until 1935—36 — on the supposition naturally, that the cod stock is not forced to emigrate through sudden, catastrophic changes or does not become decimated in some way.

Food of the Greenland Cod.

In the years investigations were made at Greenland the stomach contents of a very large number of cod were examined.

The animals which supply nutriment to the cod are both fish and various lower animals, partly from the bottom and partly from the plankton.

Among the fish the capelan (*Mallotus villosus*) plays a very great part, especially when it comes into the coast in spring to spawn, and the cod often follows these large shoals on the surface; later in the year also it frequently occurs in the cod stomachs at various places. For example, the cod taken at Fiskenæsset in September 1908 were crammed full with capelan, and the cod in quantities pursued the shoals of this fish. Similarly, at Kôrnok in the Godthaab Fjord the cod in August 1926 were all so filled with capelan, that they threw up quantities on being hauled in and the stomachs in addition to some few *Euphausidæ* contained this fish almost exclusively. In 1926 many capelan were found in the stomachs of cod from the Fylla Bank, as was also reported by the Faeroese who were fishing there, whilst in 1925 it was extremely rare in the cod taken by the "Dana" on the Bank. Perhaps the abundant occurrence of small, four-year old cod on the banks in 1926 was due in great part to the fact, that the capelan that year occurred out here in specially large quantities.

Next to the capelan the sand-eel (*Ammodytes*) seems to be important food. At Sukkertoppen especially in August—September this fish is found in great quantities in the cod stomachs.

In the larger cod taken in shallow water near the coast were often found the sea-scorpion (*Cottus*), Uvak (*Gadus ogac*), gunnel (*Centronotus*) and others of the fishes specially bound to the seaweed belt. It is often the large sea-scorpions and the uvak which form the booty of the cod, and possibly the reason for the scarcity in later years of these forms at a few localities is due to the efforts of the cod.

Thus in 1909 no sea-scorpions or uvak were found in Amitsuarssuk in the Neria Fjord, but many cod, whilst the former were common in the Neria Fjord outside where

the cod did not occur. Similarly in 1929 both the Cottus and uvak were quite scarce in the sounds at Cape Farewell, and all reports from the native Greenlanders there indicated, that these species were abundant earlier up to about 1924, but then they became scarcer and scarcer gradually as the cod increased in numbers.

Something similar applies to the Agdluitsok Fjord. Here the "Tjalfe" Expedition caught many large uvak at great depths in the time when the cod were absent. In 1929, however, this fish had almost totally disappeared from these depths; only a few quite small specimens were taken. Neither the capelan nor the sand-eel was found in the cod stomachs at this place or in the sounds near Cape Farewell.

For the large cod the long-rough dab (*Hippoglossoides platessoides*) and the cat-fish (*Anarrhichas*) also have a certain importance, both at the coast and on the banks.

In 1925 the stomachs of two large cod taken by the "Dana" on June 19 at the south end of the Little Hellefiske Bank contained several scopelids (pelagic deep-water fishes); this indicates that these cod had just migrated from greater depths up on to the bank.

Of bottom forms among the lower animals various crabs and worms have special importance as cod food.

In shallow water the most important are the prawns (*Palæmon*) and the shrimps (*Crangon*) and amphipods (*Gammaridae*). One often finds the small cod filled with *Caprella* and pieces of brown alga (*Laminaria*), which have been included when the cod snapped at the animals on the vegetation, where they are firmly fixed.

At great depths the large, red, deep-water prawn (*Pandalus borealis*) is an important food. Almost all the large cod taken in 1929 at great depths in the Agdluitsok Fjord and in the sounds at Cape Farewell contained these large prawns. Crabs are also found at a few localities; in 1925 especially many were found in the cod from the banks, where of 65 cod examined 48 contained crabs. It was clear, that crabs (*Hyas coarctatus*) formed the most important food here. Next to the crabs come the shrimps, which were found in 21 specimens, and worms (in 20 specimens).

At Nuk in the south district of Julianehaab several large cod from deep water had their stomachs filled with large, red sea-anemones.

Bivalves do not occur so often and then mostly in the stomachs of the large cod; most often they are the Greenland cockle (*Cardium groenlandicum*), scallops (*Pecten islandicus*) and *Leda pernula*, and sometimes the long breathing tube of the sand mussel (*Mya truncata*) is bitten off. In the thin cod taken in Amitsuarssuk in 1909 many bivalves such as *Macoma calcarea* and *Leda pernula* were found, often large specimens with thick shells, undissolved in the gut, obviously a food which the cod attacks only in necessity.

Whelks (*Buccinum* etc.) apparently have but an extremely small importance.

Among the plankton animals the young of a small cuttle fish (*Gonatus fabricii*) are very important as cod food, especially late in summer, when they appear in large shoals right in at the coast and are eaten not only by cod but also by gulls and eider ducks. As they have a length of only 2—3 cm., they can also be eaten by the small cod. At Sukkertoppen in August—September the cod are often quite full of these animals; this was also observed, though to a smaller degree, at Sydprøven.

Of the plankton Crustacea the feather crabs (*Euphausidae*) are of special importance. In September 1929 for example several cod were caught in the south district of Julianehaab on long lines, which had not taken the hooks at the bottom, as could be judged from the fact that they did not contain bottom-animals, but plankton forms, and among these the feather crabs were predominant. These were also found in the cod at Kôrnok in August 1927; the main constituent of the food here, however, was the capelan.

Crab larvae, which occur in the fjords and close to the coast in very large swarms in June—July, are also eaten by the cod, but are certainly of but little value as food. In July 1926 a number of cod were caught in Kôrkut in the Godthaab Fjord which only contained Crab larvae; the cod here were quite specially greedy and eagerly bit at the jig, and when the fish was brought up it was followed almost every time by several cod, which snapped at the line right up to the surface.

The same thing may be observed at localities where the cod is obliged for a time to live mainly on Ctenophores (*Beroë* and *Bolina* species), which are everywhere common from early in summer to late in autumn. These fairly large jelly-like animals contain so much water, that they cannot signify much as food material. They are often consumed in such large quantities, that the cod vomits them up in large numbers on being hauled in.

The small fry of the Greenland halibut (*Reinhardtius hippoglossoides*) in transition to the bottom-stage occur in large numbers in cod stomachs at Sukkertoppen in August—September; this was observed in 1924, 1926, 1927 and 1928. These fry were also noted in cod stomachs in the sounds at Cape Farewell in September 1909, but in the autumn of 1929 not a single specimen was found in the cod of these waters.

Marking Experiments to Elucidate the Migrations of the Cod.

The Danish Commission for Marine Investigations and the Greenland Government have cooperated in recent years in the marking and liberation of cod at various places in West Greenland; 416 specimens were marked and set free in 1924, 410 in 1925, 340 in 1926, 201 in 1927 and 109 in 1928; thus altogether 1,476 cod[1]). Up to the present time 55 specimens of these are known to have been recaptured at Greenland.

Recaptures of cod at Greenland in the different years.

Marked in	Recaptured in 1924	Recaptured in 1925	Recaptured in 1926	Recaptured in 1927	Recaptured in 1928	Recaptured in 1929
1924.....	1	..	4	5	1	..
1925.....	..	15	11	2	2	3
1926.....	..	..	..	3	..	..
1927.....	..	..	..	5	3	..

[1]) In addition, 500 specimens set free in 1929 in the Julianehaab District and 1450 in 1930 in Julianehaab, Frederikshaab and Godthaab districts.

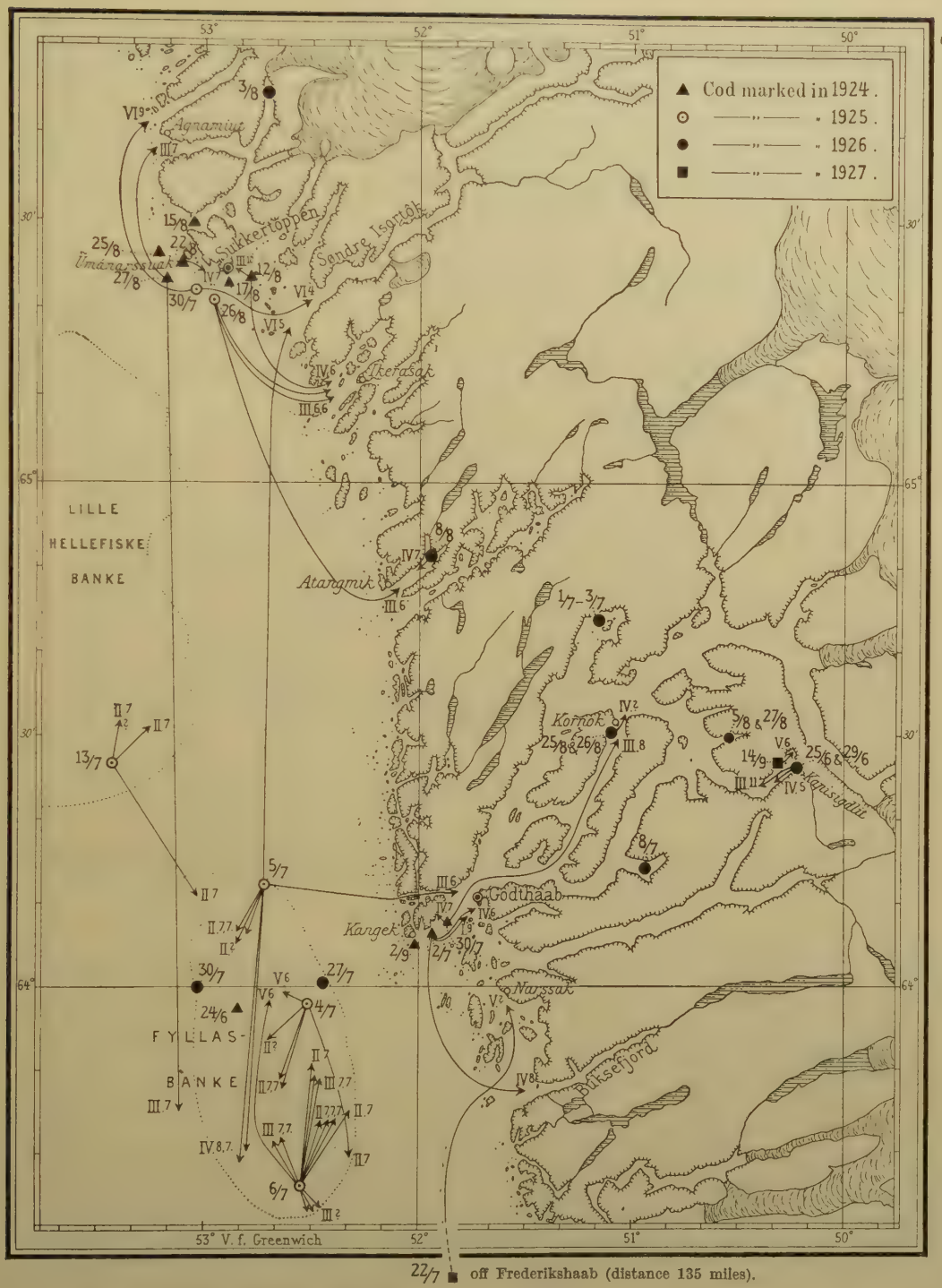

Fig. 9. Chart showing the places where marked cod were liberated and where they were recaptured. Arrows are drawn between the places of liberation and recapture. Dates of recapture are indicated as follows: I — 1924, II — 1925, III — 1926, IV — 1927, V — 1928 and VI — 1929; the index numbers alongside the years show the months of recapture, 1 — January, 2 — February, etc.

It will be seen that 21 cod were retaken in the same year as they were liberated, 17 the following year, 6 after two years, 7 after three years and 4 after four years' freedom.

It is not surprising that the 21 cod retaken in the same year, and which had only spent a few days in the sea after liberation or at most $^1/_2$ to $2^1/_2$ months, were recaptured at the same place where they were set free or very near it. The remarkable thing is, however, that by far the most of the others retaken were also caught near the place of liberation, though in the interval they had passed $8^1/_2$—50 months in the sea.

Fig. 10. Chart of Ikertôk Fjord, at the head of which cod were marked and liberated in 1927. For explanation of signs, see Chart Fig. 9.

Some few cod were recaptured at a comparatively great distance from the place of liberation; especially the following examples.

One specimen liberated on the Fylla Bank July 5, 1925, was retaken June 26, 1926, in the Godthaab Fjord near Godthaab.

Another liberated on the Fylla Bank July 5, 1925, was retaken May 9, 1929, in South Isortok inside Sukkertoppen.

One specimen liberated at Frederikshaab July 22, 1927, was retaken in the following year at Narssak, at the southern inlet to the Godthaab Fjord.

A specimen liberated at Ũmánarssuak (at Sukkertoppen) August 27, 1924, was retaken July 21, 1926, to the south-west of Fylla Bank.

As to the cod recaptured at Greenland the charts Fig. 9 and Fig. 10 give a schematic summary of the preliminary results of the marking experiments. Through these one obtains an impression of the stationary nature of the cod on the whole. And it will be noticed, that the longer migrations go both north and south, from the fjord mouth into the fjord, and from the fjord interior out towards the mouth, from the banks in towards the coast and from the coast out to the banks, as well as from bank to bank.

Since this summary was concluded, other 20 of the cod marked and liberated at Greenland have been retaken there in 1929 and 1930, 15 of them at the same place where they were set free or near by it. One of these cod had spent *64 months* in the sea and was yet recaptured at the very place of its liberation (the mouth of Godthaab Fjord). Another cod, liberated and retaken on the Dana Bank, had spent 60 months in the sea; a third liberated at Sukkertoppen and retaken a little north

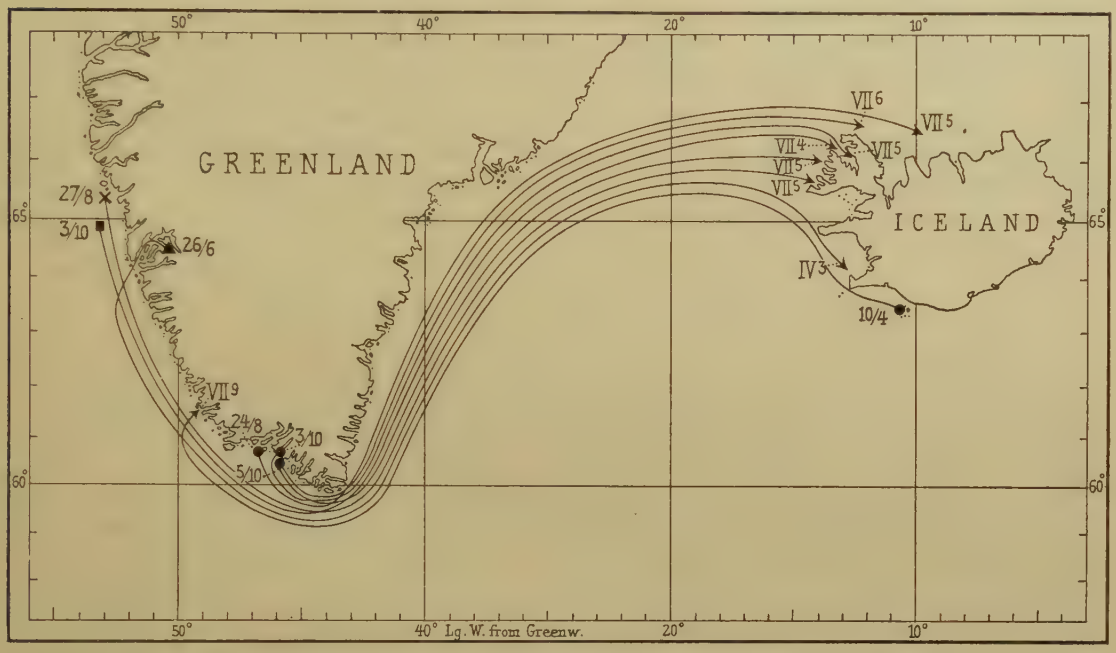

Fig. 11. Cod marked at Greenland recaught at Iceland, and vice-versa.
× Marked in 1924, ▲ in 1926, ■ in 1928, ● in 1929. IV Recaptured in 1927, VII in 1930; the index numbers alongside the years show the months of recapture, 3— March, 4— April, etc.

of it (Agpamiut) had spent 50 months in the sea; a fourth, liberated and retaken on Fylla Bank had spent 46 months in the sea; the other cod were recaptured 1—11 months after liberation. 5 were recaptured at a greater distance from their place of liberation, viz: one specimen liberated July 13, 1925 on Little Hellefiskebank, was retaken July 18, 1930 at Holstensborg; another liberated on Little Hellefiskebank July 13, 1925, was retaken August 4, 1930 off Søndre Strømfjord; one liberated at Frederikshaab July 23, 1927 was retaken August 18, 1930 at Holstensborg, one likewise liberated at Frederikshaab July 22, 1927 was retaken in the spring 1930 at Nanortalik, Julianehaab district, and one specimen, liberated in the sounds at Cape Farvel September 7, 1929 was retaken May 23, 1930 at Kôrnok in the Godthaab Fjord.

Apart from a single example, previously considered as doubtful, none of the cod marked at Greenland in the early years had been recaptured outside that region. But a change has occurred recently, for during the spring of the present year (1930) six specimens have been retaken at North-west Iceland, where the earlier discovery regarded as uncertain had also been made.

Thus seven specimens in all of the cod marked at Greenland have been retaken at Iceland, namely 1 in 1927 and 6 in 1930; of these one was marked in 1924, one in 1926, 1 in 1928, and 4 in 1929. Of the recaptured cod one was liberated at Sukkertoppen, one on the Little Hellefiske Bank, one at Kapisigdlit in the Godthaab Fjord, and four in the neighbourhood of Julianehaab (cf. Schmidt p. 8 and Fig. I; see also our Fig. 11).

Further it appears from one marked cod recently recaptured that migration in the opposite direction may also occur as a cod marked and liberated April 10, 1929 at Vestmannaøerne (S. W. Iceland) was retaken September 17, 1930 in the Neriafjord south af Frederikshaab (cf. Fig. 11).

Time of the Cod's Appearance on the Banks.

It is well-known, that the cod first appears somewhat late on the banks in the Davis Straits, varying in different years from the beginning of June to the end of this month or beginning of July. That they must appear earlier in the immediate neighbourhood of the banks, is apparent from the fact, that the investigations of the "Dana" in June of 1925 found cod eggs obviously just spawned over and just outside the banks, whereas no cod were found on the banks; yet on the south edge of the Little Hellefiske Bank some cod were taken which had pelagic deep-water fish (scopelids) in their stomachs and had thus obviously migrated from greater depths up to the edge of the bank. Further, reference may be made to the fishing experiments with motor boat on the Fylla Bank June 11, 1927, which yielded no cod down to about 50 m., whereas at the same period the "Islands Falk" obtained rich catches of cod at about 90 m. Similarly, according to the Norwegian fishery leader Engvald Baldersheim considerable quantities of cod were caught as early as in May and June on the western edge of the Little Hellefiske Bank where it slopes down to deep water and on the slope of the Little Hellefiske Bank outside Strømfjorden[1]).

It has already been remarked with regard to the time when the cod immigrate on the banks, that this varies somewhat in the different years, and it is obviously dependent to some extent on the temperature of the bottom water. Yet it is apparently not possible to state any definite temperature at which the immigration takes place. As examples the following may be given: in 1924 on June 24, depth 42 m., a bottom temperature of 2.5° C. was measured on the Fylla Bank, and cod were caught there; in 1925 the bottom temperature on June 18 at 50 m. was only 0.3°—1.06° C. and there were no cod, whereas on July 4—6, the bottom temperature had risen to 0.87°—1.68° C., and the cod had arrived on the bank; in 1926 on June 12 a temperature of 2.2° C. was measured at a

[1]) Cf. Hjort & Ruud, 1929, p. 27.

depth of 45 m. and cod were taken; in 1927 on June 11 a temperature of 1.94° C. was found at 48 m., but there were no cod, though cod were found at a depth of 90 m. (but no temperature measurements were taken); in 1928 on June 18 a temperature of 1.77° C. was found at the bottom, but still no cod.

The lowest temperature at which cod were taken on the Fylla Bank in appreciable quantities, was thus 0.87°—1.68° C.

According to evidence from the inspection-vessel "Islands Falk" as well as from Faeroese and Norwegian fishing vessels, the cod made its appearance on the Fylla Bank at the following times: in 1924 and 1925 at the end of June, in 1926 and 1927 in the beginning of June, in 1928 and 1929 at the end of June.

At what time the cod again leaves the banks, we know but little; it can only be said, that in 1925 practically no fishing was carried on after the middle of August on the Fylla Bank. Baldersheim states also, that the cod for the most part only visit Fylla Bank in July and August, whereas even at the end of September large quantities of cod were often present on the edge of the slope of the Little Hellefiske Bank towards deep water, partly on the west side as also off the Strømfjord.

Changes in the Marine Fauna of South-West Greenland at the Time of the Mass-Occurrence of the Cod.

The great change and increase shown in the stock of cod at Greenland in recent years is not the only sign, that great changes have occurred in the animal life of the waters at South-West Greenland. Only a few, specially noteworthy examples of this need be mentioned here.

The well-known gadoid coalfish (*Gadus virens* L.), which had not been noticed at Greenland since far back in the previous century, has in recent years — since 1924 — not seldom appeared along with the cod shoals in the districts of Julianehaab, Frederikshaab, Godthaab, Sukkertoppen, and Holstensborg. The coalfish even seems to spawn at Greenland; in addition to adult specimens, of about 1 m. in length, small specimens of 21—34 cm. in length, belonging to the I-group, were caught at Sukkertoppen and especially in the Julianehaab District; at Arsuk (north of Julianehaab) these two-year old coalfish came right in to the beach in very large quantities this year. Further, in October 1929 off Sydprøven (south district of Julianehaab) a well-grown specimen, 61 cm. long, of another gadoid was taken, namely haddock (*Gadus aeglefinus* L.), a species that had not been known earlier from Greenland.

The herring (*Clupea harengus* L.), almost an unknown fish at Greenland otherwise, has appeared quite recently, even in quite large shoals, in certain fjords of the Sukkertoppen, Godthaab and Julianehaab districts, both small herring (down to a length of 12 cm.) and large herring (37—42 cm. long), some of them with running milt and eggs; in 1930 ($^4/_8$) even specimens only 5—6 cm. long (I-group) were taken in Tunugdliarfik Fjord (Julianehaab district).

The coalfish, haddock and herring from a Greenland standpoint are considered

southern species, and it is significant that they arrive at southern West Greenland just when the cod appears in enormous numbers.

On the other hand we find at present, that arctic animal forms remain away or shorten their stay at South-west Greenland. The white whale, also called white fish (*Delphinapterus leucas* Pall.), which in summer lives far to the north but in spring wanders southward and passes the winter along the west coast about the Polar Circle, has not appeared in recent years, according to information received from the fishmaster N. L. Nielsen, before the middle of November at Sukkertoppen and returns northwards again already in January; — formerly, it arrived at Sukkertoppen in the middle of October and did not migrate away again before April and early in May; most recently the white whale has been almost totally absent in winter here to the south, but has been observed on the other hand to have prolonged its stay in the north. And the small herring-like salmonoid Lodden or capelan (*Mallotus villosus* Müll.), which earlier in the early summer of each year had swarmed in towards the coastal waters in enormous numbers, from Disco Bay right down to the south point of the land, for spawning purposes, have remained away from most of their former fishing grounds in the South Greenland waters in recent years. Further may be noted, that the arctic flat-fish Greenland Halibut (*Reinhardtius hippoglossoides* Walb.) has occurred in recent years in far smaller quantities than earlier in the southwesternmost fjords of Greenland.

We could have wished to add to this account of the great changes in the animal life which have occurred in the waters of S.W. Greenland — they are indeed so far-reaching and so great in character that we hardly know of anything similar — some suggestion as to what might be regarded as the cause of these phenomena. It must be obvious beforehand, that the causes are to be sought for in changed natural conditions, such as currents, ice conditions, temperature, production etc. We must abstain, however, at the present time from entering upon a discussion of such things, for the necessary material is in part difficult to obtain, as the observations and collections of later years have not yet been worked up in final form, partly because the material is in itself somewhat fragmentary. At a future occasion, however, we intend to examine more closely these interesting and important conditions.

We make only the following remark here, that the natural conditions at South-west Greenland have been quite out of the ordinary in recent years; the "Storis" has not been nearly so abundant as earlier, and the western ice has generally had a more restricted distribution than before; the winters have been unusually mild etc.

Much indicate that the polar current, which descending from the Arctic bends round the south point of Greenland and runs farther along the south-west coast as a cold stream, has been much less prominent than in earlier years. The relatively high temperatures, which have been measured recently along the coast and in the fjords of South-west Greenland, confirm this.

One must be prepared, however, for a swing back to the earlier condition, which naturally would exercise an influence on the fish stock.

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II

MISSIONS DE RECHERCHES AU GROENLAND
(CAMPAGNES 1929 ET 1930)

PAR

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I. Motifs des Recherches effectuées au Groenland.

La Grande pêche française à Terre-Neuve subit depuis 1927 une crise particulièrement sensible pour les armements de cordiers à voiles, qui pêchent en été, sur le Grand Banc, mais qui est également dure pour les chalutiers pendant les mois de juin à octobre.

La situation se présente différemment pour les deux modes d'exploitation des fonds. Sur les fonds de moins de 100 mètres, seuls fréquentés par les cordiers, le poisson s'est raréfié au point de réduire la moyenne des captures à la moitié à peine de la production normale; sur les grands fonds, fréquentés par les chalutiers, la morue semble disparaître, dès le mois d'avril, pour être remplacée par l'ânon, qui est d'une valeur commerciale très inférieure.

La première année déficitaire depuis la guerre, si l'on excepte 1922 qui fut peu satisfaisante, se présenta en 1927.

Deux thèses se trouvaient alors en présence, pour expliquer hypothétiquement l'existence bien souvent constatée déjà des années déficitaires: l'une était due à Mr. Le Danois qui avait commencé les recherches océanographiques et biologiques françaises en 1922 et 1923, l'autre à Mr. Rallier du Baty, chargé de mission de l'Office des Pêches en 1925 et 1926.

L'année 1927 se présentant comme mauvaise, il allait être possible de confronter les deux explications avec les faits.

Monsieur Le Danois avait écrit:

»La température exerce une grande influence sur les mouvements des morues; elles recherchent les eaux froides entre — 2° et + 6°. Cette habitude des morues donne une grande importance à l'étude des conditions hydrologiques pour la détermination de leurs mouvements.

»La pêche de la morue sur le Banc de Terre-Neuve commence pratiquement fin avril pour se terminer en fin septembre. Elle embrasse donc une période comprenant une partie de l'hiver, avril et mai; le printemps ou l'apparition de l'été, juin et juillet; une partie de l'été, août et septembre. Je prends ici les saisons au point de vue hydrologique et naturellement pas au point de vue atmosphérique. Aussi bien dans le milieu marin que dans l'air, il y a suivant les années, des variations dans la précocité des saisons; il se pourra donc que certaines conditions que nous avons constatées en mai se réalisent suivant le cas, ou en avril ou en juin, d'où une première source de modifications dans les conditions hydrologiques et dans la pêche.

»Les plus importantes variations ne consistent pas en la plus ou moins grande précocité des phénomènes saisonniers, mais en leur amplitude; suivant cette amplitude, nous avons des années chaudes, des années moyennes, des années froides.

»Années chaudes. Les pêcheurs du Banc de Terre-Neuve les connaissent bien; elles sont généralement désastreuses. Un armateur à St Malo, lors d'une récente réunion en cette ville, m'en a cité

un certain nombre, dont plusieurs furent consécutives aux phénomènes sismiques de la Martinique. Au point de vue hydrologique, ces années chaudes se manifestent par une accentuation de l'envahissement des Bancs par les eaux chaudes; au lieu d'avoir 30 mètres d'épaisseur, la nappe à + 8°, + 10°, + 12°, a 50 ou 60 mètres d'épaisseur. Le résultat est que la morue disparait; en effet, ce poisson ne fréquente guère les eaux d'une température supérieure à + 6° et ne fréquente pas du tout celles dont la température dépasse + 8°. Ainsi une transgression chaude trop massive fait-elle déserter le Banc par les morues qui se réfugient ailleurs, peut-être dans les eaux de la baie de Plaisance.

»Années moyennes. Marquées vers le milieu de la saison de pêche par un réchauffement des couches superficielles presque vers 30 mètres; au-dessous, les eaux restent froides à une température voisine de 0°. Ces années sont favorables à la pêche; en effet la morue reste sur le fond à une température qui lui est propice, et en surface dans les eaux chaudes on peut pêcher l'encornet. La coexistence en un même endroit, mais à une profondeur différente de la morue en eau froide et de l'encornet en eau chaude, réalise les meilleures conditions de la pêche du Banc de Terre-Neuve.

»Années froides. Par suite d'un développement exceptionnel du Cold Wall, il n'y a pas de réchauffement, ou seulement un réchauffement très faible et tardif dans les couches superficielles des eaux du Banc. Ces années ne seront pas particulièrement mauvaises car il y aura beaucoup de morues, mais les pêcheurs seront gênés pour boëtter leurs lignes, car l'encornet manquera, et il faudra, pendant toute la saison boëtter avec des bulots.

»Par suite de la préférence des morues pour les eaux froides, les bonnes années de pêche seront donc des années à réchauffement estival restreint. Cet exposé, basé sur des recherches scientifiques, confirme donc le vieil adage établi empiriquement par les pêcheurs du Banc que les années où il y a beaucoup de glaces sont des années de bonne pêche. Ces années où les glaces sont abondantes sont, en effet, celles où les eaux de fusion donnent au Cold Wall une importance suffisante pour simiter aux couches superficielles le réchauffement du grand Banc.«

Par contre Mr. Rallier du Baty écrivait en 1925:

»Si l'on admet, selon toute apparence, que la morue est un poisson modérément sténotherme et sténohalin, on est obligé d'en tirer la conclusion que pour raréfier la morue sur les Bancs, il suffirait d'un écart relativement peu considérable des deux facteurs, température et salinité.

»Les variations de salinité d'une année à l'autre sont si minimes que l'on peut éliminer d'emblée ce facteur en tant que cause d'une mauvaise saison de pêche.

»Restent les écarts de température. Suivant l'amplitude du réchauffement estival des eaux, M. Le Danois estime qu'il doit y avoir, hydrologiquement parlant, des années chaudes, des années moyennes et des années froides. Il estime que les mauvaises pêches doivent coïncider avec les années chaudes qui, par un réchauffement exagéré de l'eau des Bancs, ont pour résultat d'en chasser la morue.

»Rien dans les recherches faites depuis quelques années dans la région de Terre-Neuve ne vient infirmer ni corroborer cette hypothèse. Elle a cependant un point faible qui est le suivant. Un des principaux caractères du réchauffement quelle qu'en soit la cause, est la lenteur. Il se produit progressivement à partir d'avril pour atteindre son maximum en septembre ou même en octobre. Il est donc difficile d'admettre que ce réchauffement puisse devenir gênant pour la morue dès le début de la saison de pêche.

»Nous savons en effet que la morue adulte peut supporter des températures allant jusqu'à 10° et la jeune morue jusqu'à 20°. Dès lors, si ce réchauffement gênant ou prohibitif ne se produit qu'en fin de saison, il ne peut avoir de répercussion très importante sur le produit de la pêche. On sait en effet que beaucoup de voiliers terminent leur cargaison dès le mois d'août. Donc, pour que l'hypothèse de mauvaise pêche par suite d'un réchauffement excessif des eaux reste plausible, il faut admettre à priori un réchauffement précoce, brusqué d'une ampleur formidable, pénétrant en profondeur et annulant le pouvoir réfrigérant de l'appareil labradorien.

»Il nous reste à examiner maintenant l'hypothèse contraire, celle de la raréfaction de la morue par suite d'une activité extraordinaire du courant du Labrador, combiné ou non avec un manque d'ampleur du phénomène du réchauffement estival.

»Supposons que pendant la majeure partie de la saison de pêche, la surface des Bancs de Terre-Neuve reste baignée par de l'eau à — 1° ou — 2°. La morue, gênée par cette température extrême, n'y ferait que de courtes apparitions et rechercherait plus au sud ou en profondeur, des conditions plus favorables.

»Cette hypothèse n'est pas moins plausible que la précédente, elle a même sur l'autre, l'avantage de pouvoir s'imposer dès le commencement et jusqu'à la fin de la saison, sans faire appel à un grand bouleversement des conditions normales. Si l'on interroge les Terreneuvas qui ont connu les années de disette de 1903 à 1906 et de 1911 à 1914, ils vous répondent que ces années ont été marquées, non seulement par la rareté de la morue, mais encore par l'apparition tardive et le séjour très court de l'encornet. Or l'apparition tardive et courte de l'encornet est le signe indubitable d'un manque d'amplitude du phénomène de réchauffement, l'encornet étant un animal essentiellement sténotherme.

»Pour savoir laquelle des deux hypothèses est la bonne, il faudra attendre le retour d'une mauvaise année. Souhaitons que ce soit le plus tard possible, car mieux vaut faire de bonnes pêches sans en connaître la cause qu'en faire de mauvaises en sachant pourquoi.

»Il convient cependant de ne pas perdre de vue que connaître la cause du mal permettrait d'en chercher le remède. En l'occurence, ce remède serait vraisemblablement d'aller pêcher plus au Nord, au Labrador et au Groenland si la première hypothèse était reconnue la bonne; plus au sud, sur les Bancs de Nouvelle-Ecosse et du Golfe du Maine dans le cas contraire. Il faudrait rechercher aussi, dans les deux cas, si la morue ne se réfugie pas sur les pentes.«

Nos recherches pendant les années 1927, 1928, 1929 s'attachèrent principalement à préciser les points suivants:

Quelles sont les conditions d'une bonne pêche, pour les chalutiers et pour les cordiers?

Quelles peuvent être les causes de la situation hydrologique et biologique qui accompagne les bonnes pêches?

Que faut-il faire pour remédier au caractère périodique du retour des conditions défavorables à une bonne pêche?

En nous attachant à noter dans nos enquêtes les températures et salinités constatées comparativement à l'importance des captures, à examiner l'état de maturité sexuelle des morues dans tous les cas, à faire état de la nourriture de la morue capturée, de la présence ou de l'absence de la boette de passage (capelan, hareng, encornet et de la richesse du plancton), nous sommes arrivé aux conclusions suivantes que nous avons toujours vues confirmer.

I. Les chalutiers font leurs meilleures pêches dans les piaules de rassemblement de morues en état de maturité sexuelle, ou dans les taches de morues en train de frayer.

Les cordiers font leurs bonnes pêches, soit dans les conditions précédentes, soit dans les formations denses de morue en plaine, séjournant sur des fonds riches qu'elle vient occuper, après le frai, pour se refaire anatomiquement.

II. Les passages de boëtte de surface ne troublent que momentanément la pêche. La morue, en effet, se lève du fond, au moment des passages, sans dépasser le plafond que constitue pour elle la tranche superficielle des eaux plus chaudes, et sans pénétrer dans les eaux de plus de 10°. Lorsque la boëtte de passage descend, avec le plancton vers la tranche d'eau intermédiaire (25 à 30 mètres), la morue monte s'en repaître, et lorsque cette boëtte regagne la surface avec le plancton (en général de nuit, le poisson redescend au fond et cherche sa nourriture dans la faune de fond.

III. La morue recherche pour frayer la couche d'eau de salinité 33 à 34 et de température 3° à 5° qui semble constituer la zône optima de son habitat à la condition que cette couche soit adhérente au fond. Lorsque cette couche d'eau est profonde, et baigne seulement les talus du plateau continental, la morue est extrèmement dense, mais les bancs de poisson sont difficiles à trouver car ils sont très limités en largeur. Lorsque la couche d'eau favorable que nous avons appelée pour cette raison l'eau de morue baigne une grande étendue superficielle des bancs de faible profondeur (moins de 100 mètres), la morue est plus dispersée peut-être, mais extrèmement abondante et l'on peut considérer que c'est l'existence d'une zône plate couverte d'eau de morue qui détermine le caractère d'une saison de pêche, dans une région donnée.

Les captures répétées de morues portant à la gueule un hameçon de cordier travaillant au nord de la tranche d'eau de morue, dans l'eau plus froide de 1°5 à 3°, faites par des chalutiers travaillant dans l'eau de morue, prouvent, à n'en pas douter, que ces morues, dont l'état de maturité sexuelle est manifeste, cherchent à gagner la tranche d'eau favorable dont un sûr instinct leur révèle l'approche dans le voisinage.

Les voiliers feront de meilleures pêches dans le voisinage immédiat de l'eau de morue que dans les eaux plus froides.

On ne trouve que très rarement de la morue dans les eaux de moins de 2°; on n'en trouve qu'exceptionnellement dans les eaux de plus de 7°. Il en résulte que l'aire occupée par le poisson dans une région donnée est très limitée et fonction des mouvements d'eau dans la zône envisagée. En particulier, si l'eau de morue fait défaut sur une aire donnée pendant une année, cette région se dépeuplera complètement l'année suivante et cela d'autant plus qu'elle sera plus éloignée des conditions de température et de salinité de l'eau de morue.

On constate que l'eau de morue est remarquablement riche en plancton, particulièrement en méganyctiphanes et thysanoessa. Ces schizopodes apparaissent dans la tranche de 0 à 25 mètres à la suite d'une prolifération considérable de frai de méduses, lorsque l'eau polaire est abondante sur les bancs. Au contraire ils fond défaut lorsque les eaux atlantiques ou les eaux de pente de plus de 34 de salinité l'emportent, et leur disparition entraine celle de l'encornet.

IV. La présence de l'eau de morue à un étage convenable du talus continental étant la condition sine qua non des bonnes pêches, il importe de rechercher dans quelles conditions elle se produit. Des études comparatives que nous avons faites en procédant à différents mois de l'année de février à novembre, à des coupes hydrologiques s'étendant de la surface à 200 ou 250 mètres, il résulte les conséquences suivantes:

Suivant la phase du rythme périodique des transgressions chaudes atlantiques dans laquelle on se trouve dans l'année considérée, on peut diviser les années successives en années froides, moyennes ou chaudes, suivant que la transgression est normale ou moyenne, ou bien qu'elle est faible (années froides) ou forte (année chaudes).

Or que constate-t-on à Terre-Neuve dans ces trois cas?

Année moyenne. Du mois d'avril au mois de juillet, le courant labradorien charrie une abondante quantité d'icebergs détachés du Groenland par la fonte du printemps ou de l'été précédent. Ce mouvement des icebergs est accompagné d'un afflux d'eau froide

produit par la fonte qui alimente en cours de voyage le courant labradorien et tend à s'opposer à son réchauffement par l'influence solaire ou par le contact des eaux atlantiques. La masse ainsi entretenue descend vers le sud avec un volume déterminé et produit, dans l'ensemble des eaux qui l'entourent, l'effet d'un fleuve de profil vertical déterminé et d'un débit déterminé. Ce fleuve ne s'étend pas obligatoirement de la surface au fond: c'est une question de densité. Les berges de son lit, tant verticales que sous-jacentes, sont constituées indifféremment par des terres ou par des eaux de nature différentes, des eaux atlantiques qui tendent à le comprimer, à l'empêcher de se dilater, de s'étendre en largeur et en profondeur. Le mouvement de la terre entraîne cette masse contre la côte américaine et de ce côté elle sera nettement délimitée, mais vers l'est et vers le fond, les limites en seront absolument variables, non seulement avec les saisons, mais avec le rythme des transgressions chaudes. La profondeur de cette masse variera essentiellement d'une année à l'autre, en même temps que sa densité, combinaison de la température et de la salinité. En 1926 les salinités de 31 $^0/_{00}$ sont fréquentes sur le banc, au moins en surface, même en août. En 1928, elles ne descendent guère dans l'est au-dessous de 33 $^0/_{00}$. La couche d'eau polaire est beaucoup moins abondante, mais pas seulement dans le sens horizontal; elle est peu épaisse relativement.

Dans les années moyennes les minima de température (au dessous de 0°) qui se trouvent à la base de l'eau polaire, atteignent des profondeurs de 150 à 200 mètres à la latitude des Bancs. Qu'en résulte-t-il? C'est que cette couche d'eau, impropre à la vie du poisson ne peut pénétrer par le couloir d'Avalon situé entre le Grand Banc et Terre-Neuve qui n'a que 130 mètres de profondeur maxima, ni à fortiori par le détroit de Belle-Isle, entre Terre-Neuve et la côte américaine. Toujours appliquée par la rotation de la terre contre le talus continental américain, la couche d'eau glacée passe en dehors des Bancs, entre le Bonnet Flamand et le Grand Banc, dans la Coursive. A cause de sa densité plus forte, cette eau ne peut s'élever au dessus du talus qui constitue pour elle un barrage infranchissable.

A l'abri derrière ce mur se fait la poussée des eaux chaudes, poussée moyenne par définition, puisque nous sommes dans les années de transgression normale. Cette eau chaude de densité plus faible que l'eau polaire s'insinue au cœur des Bancs par les coulées et vallées qui en sillonnent l'étendue: Chenal du St Laurent, Chenal du Flétan, de l'Eglefin de la Baleine. On remarque, en faisant une coupe verticale dans ces chenaux que les eaux respectives prennent chacune leur droite, les eaux froides venant du Nord sont toujours à l'Ouest des chenaux; les eaux chaudes venant du Sud sont toujours à l'Est. A un instant donné de l'année, une région donnée est baignée par l'eau de morue qui est entrainée par le rythme des transgressions exactement comme les eaux de nature différente et avec elle arrive la morue. C'est parce qu'en année normale la tranche caractéristique de l'eau de morue (3° à 5° et 33 à 34 de salinité, sur le fond) est abondante à Terre-Neuve que ces bancs sont célèbres depuis 600 ans pour les captures qui s'y font.

Année froide. Dans le cas d'une année froide, il n'y a rien de changé essentiellement au processus qui vient d'être décrit. Le courant froid est plus puissant, plus ample, la profondeur des densités maxima et températures très basses dépasse 250 mètres. Quant

à la surface, elle connaîtra le réchauffement estival normal à des latitudes de 45°. On remarquera seulement une abondance formidable d'organismes polaires, charriés par l'eau de surface, amphipodes et schizopodes; l'encornet très friand de ces crustacés foisonnera, dès que l'eau de surface aura atteint la température de 5° par réchauffement solaire; ce sera une excellente année de pêche. Les eaux chaudes de 50 à 100 mètres seront encore suffisantes pour envoyer par les chenaux de distribution l'eau de morue sur de très grandes aires de pêche et les captures seront très fortes (type 1926).

Année chaude. Au contraire que se passe-t-il dans le cas des fortes transgressions chaudes? Les minima de température, au lieu de se trouver par 250 mètres, le sont par 50 ou 75 selon la latitude. L'eau polaire est étriquée, peu nourrie, appliquée par le mouvement terrestre de plus en plus vers l'est, à mesure que le flot froid perd de son importance en descendant vers le sud. Par tous les chenaux des Bancs l'eau glacée de 0 à —1°5 s'insinue et vient inonder les petits fonds. La morue fuit. En particulier, par le détroit de Belle-Isle l'eau polaire se glisse sur les Bancs de l'Ouest. Dès le printemps, la température est désastreuse pour la pêche. Et il se produit ce phénomène paradoxal que c'est dans les années de forte transgression chaude que les Bancs pendant la majeure partie de l'été sont baignés d'eau plus froide, trop froide pour la morue. Mais ce courant polaire se tarit fatalement assez vite. Dès la mi-aout dans les fonds de 50 à 100 mètres, dès juin dans la couche superficielle, l'eau polaire peu alimentée par un fleuve épuisé, se laisse échauffer brutalement par une poussée violente des eaux atlantiques elle-même. C'est ainsi qu'en 1927 nous avons assisté à l'envahissement des Bancs par des eaux atlantiques, celles du Gulf-Stream de plus de 36 de salinité, reconnaissables à l'abondance catactéristique du raisin des Tropiques.

Cette année fut une année de forte transgression chaude. Son influence sur les Bancs fut néfaste et dure encore. Depuis cette date, l'équilibre n'a pas encore été rétabli. On ne voit plus d'eau atlantique sur les Bancs, mais chaque année depuis 1927, la situation en été est mauvaise. Le phénomène d'invasion des Bancs par les eaux froides se reproduit chaque printemps avec un certain décalage. Puis vient la poussée chaude, inondant surtout les bancs de l'Ouest vers l'automne. Cette situation troublée est défavorable à la formation étendue de l'eau de morue. On l'observe bien au printemps faisant une apparition timide aux accores du Sud, par des fonds de 200 à 250 mètres où les chalutiers font de très belles pêches; puis elle recule au lieu de monter vers le nord par suite de l'invasion des Bancs par l'eau polaire. Les voiliers pêchent de moins en moins, car la morue évacue de plus en plus les petits fonds trop rarement habitables. On s'aperçoit que le poisson, se maintenant dans la couche de 150 à 300 mètres et peut-être davantage, file vers le nord, au cours de l'été, et vient peupler les accores Nord-Est du Grand Banc dans des régions où elle est complètement inconnue en temps normal. C'est qu'en effet ces parages sont ordinairement baignés par l'eau très froide de fusion des icebergs et sont même ravagés par le glissement des glaces, tandis que dans les années chaudes, dès juillet, l'eau polaire peu abondante se réduit à un filet de 70 à 80 mètres de profondeur, large à peine d'une centaine de milles, plaqué contre Terre-Neuve, laissant aux eaux de pente et même aux eaux atlantiques toute la Coursive et le Bonnet. On voit pendant quelque temps passer dans cette région, en marche vers le nord, un nombre considérable de bancs d'encornets tandis que le centre des Bancs, beaucoup plus au sud,

en est totalement dépourvu: question de température et surtout de plancton. Les oiseaux sont là, sur les accores, avec la boëtte de surface. La morue est présente. Ailleurs elle a disparu. Est-elle descendue dans les grands fonds? Peut-être, momentanément, c'est possible; mais pour l'avoir vue filer le long du talus vers le nord, pour l'avoir retrouvée deux mois plus tard à 200 ou 300 milles plus nord, dans des parages en général inhabités, notre conviction est qu'elle est susceptible de déplacements considérables. C'est ainsi que nous avons recueilli sur les Bancs, au Trou Baleine, deux marques de morue baguées auprès de Scatari, à près de 400 milles de distance. Ces morues faisaient partie d'un banc que nous avons suivi pendant trois semaines dans ses pérégrinations sur plus de 120 milles de distance et dont une partie a certainement fait l'objet de pêches effectuées trois mois plus tard à plus de 300 milles dans le nord du point où nous les avions perdues nous-mêmes, à la pointe Sud-Est du Grand Banc.

En résumé, il semble maintenant certain que, en ce qui concerne Terre-Neuve, les mauvaises années de pêche concordent avec les années chaudes, ou de forte transgressions chaudes:

1° parce que ces années sont en même temps des années de faible apports polaires, d'où faible épaisseur de la couche froide, envahissement des petits fonds centraux par une couche d'eau glacée, —1° à +1° inhabitable à la morue, qui fait place au cours de l'été ou en automne à une invasion irrésistible d'eau également inhabitable par suite de sa température trop élevée. (18 à 20° en surface; 14 à 16° à 25 mètres; plus de 10° au fond) ou de sa salinité trop forte, contraire à l'existence des organismes polaires, impropre à l'alimentation des boëttes de passage.

Le vieux dicton populaire avait donc raison: »Année froide, année de morue.« L'hypothèse de Mr. Le Danois sur la cause profonde des années de »faillette« comme on les appelle, se trouvait vérifiée.

Ayant constaté que les bonnes pêches se font au voisinage ou dans l'eau de nature bien déterminée que nous avons baptisée pour cette raison eau de morue, ayant pu reconnaître également la coïncidence de la disparition de l'eau de morue avec l'arrivée des fortes transgressions chaudes, il nous restait à chercher le remède à une situation que l'on subit périodiquement depuis plusieurs centaines d'années sans réagir.

Proposons-nous d'abord de rechercher les fluctuations de production de la pêche à Terre-Neuve et pour cela, commençons par évaluer le rendement individuel, afin d'éliminer des résultats constatés, l'influence due aux variations de l'armement. On obtient le tableau suivant qui, en regard de chaque année donne, en tonnes, le rendement par hommes.

1881.....	2,1	1891.....	1,4	1901.....	3,5	1911.....	4,1	1921.....	6.9
1882.....	2,0	1892.....	1,6	1902.....	3,6	1912.....	3,3	1922.....	7.4
1883.....	2,5	1893.....	1,7	1903.....	2,7	1913.....	4,1	1923.....	9,4
1884.....	2,7	1894.....	1,7	1904.....	1,9	1914.....	3,0	1924.....	8,2
1885.....	2,9	1895.....	2,2	1905.....	2,4	1915.....	7,1	1925.....	11,4
1886.....	3,5	1896.....	3,2	1906.....	2,1	1916.....	5,1	1926.....	12,3
1887.....	3,9	1897.....	3,5	1907.....	3,9	1917.....	7,2	1927.....	11,1
1888.....	2,4	1898.....	3,1	1908.....	4,9	1918.....	6,5	1928.....	11,4
1889.....	2,4	1899.....	3,6	1909.....	5,8	1919.....	7,5		
1890.....	2,5	1900.....	3,3	1910.....	7,8	1920.....	6,2		

Le rendement individuel ne suffit pas à rendre la physionomie de la pêche, car il faut tenir compte de l'amélioration progressive du matériel et de l'introduction du chalutier. En groupant les données précédentes sur une courbe et en relevant les ordonnées successives par rapport à la moyenne croissante du rendement individuel, nous parvenons à éliminer en grande partie l'influence du matériel. On voir alors la courbe des rendements se former autour d'un axe moyen avec des maxima et des minima répartis comme suit:

Maxima	1887	1900—01	1910	1918	1926	
Minima.....	1882	1893	1904—05	1913	1921	

Il y a 5 minima en 38 ans soit un tous les neuf ans environ. Si l'on rapproche ces résultats des travaux du professeur Otto Pettersson sur l'existence des marées profondes et leur répercussion sur les pêche de hareng, ou encore des études de Mr. Le Danois sur les mouvements de transgression chaudes, il est impossible de ne pas être frappé par l'allure du rythme obtenu. Mr. Le Danois signale comme phases du rythme obtenu la suite d'années:

I 4.5 9 18.5 III

Géométriquement, on peut placer les époques de changement de phases aux dates

1885 1894 1903 1912 1922 1931 1940

Nos minima ayant lieu en 1882, 1893, 1904, 1913, 1921, on sent qu'il y a une liaison indéniable entre les deux phénomènes. D'autre part, on observe que sur neuf années consécutives on est en droit de compter deux années moyennes, trois au-dessus, trois au-dessous.

Si l'on considère maintenant les pourcentages obtenus dans le total des pêches américaines par les différents pavillons, on constate que le pourcentage de Terre-Neuve augmente lorsque la France pêche mal. Toutes choses égales d'ailleurs au point de vue des armements, il est évident que si la même cause atteignait toutes les flottes, l'ensemble baisserait, mais les pourcentages ne varieraient pas. Ces différences peuvent être fortes:

Année	France	Terre-Neuve
1904	12 %	49 %
1910	29 -	35 -
1921	17 -	54 -
1925	28 -	40 -

Donc, les pêcheurs de l'Ile de Terre-Neuve, qui travaillent pendant ces années de forte transgression chaude au Labrador ne sont pas atteints comme les Français qui sont au sud des Bancs par la disparition momentanée du poisson. Donc, il faut adopter cette tactique lorsque la phase du rythme des transgressions ramène automatiquement la »faillette« sur les Bancs du Sud; il faut émigrer avec armes et bagages et tâter du Groenland qui doit être excellent pendant ces années-là.

C'est pour cette raison et pour vérifier ces conclusions que l'Office des Pêches organisa en 1929 une mission de recherches au Groenland en utilisant dans ce but, le Navire-Hopital des Oeuvres de Mer, la Ste Jeanne d'Arc.

Cet exposé peut paraître un peu long, mais il était indispensable pour permettre de saisir la corrélation des recherches effectuées et simplifier le commentaire des observations qui vont suivre.

II. Recherches faites au Groenland en 1929.

1. La remontée du courant polaire. La traversée du Sydney au Banc Fylla, par temps maniable, offrait une occasion unique d'examiner le régime du courant polaire. Les moyens dont nous disposions et le temps ne nous permettaient guère de pousser nos recherches au-delà des profondeurs de 200 mètres, mais le domaine était cependant assez vaste et peu connu pour apporter des données intéressantes.

La figure 4 indique le parcours suivi et les positions des stations. Le tableau 1[1]) donne les résultats des observations. La figure 5[1]) donne une coupe schématique des isothermobathes, halynobathes et isopycnobathes. La lecture de ces relevés est intéressante.

Au Sud et au Nord, deux masses d'eau polaire comprennent au-dessus des grands fonds du détroit de Davis une masse d'eau salée d'une homogénéité remarquable comme salinité, refroidie en partie au Sud par conductibilité au contact de l'eau labradorienne. Les courbes de salinité entre les stations 91 et 92 sont absolument verticales, les températures également. C'est le passage brusque de deux masses d'eau de nature différente, se frôlant sans se mélanger, saisies à une phase quelconque de leur dynamisme et dans un état d'équilibre absolument instable. Le dernier croquis relatif aux densités *in situ* montre, en effet, entre les stations 91 et 96 une intumescence d'eau salée caractéristique qui révèle l'importance de la poussée des eaux venant du Sud. Un tel état de choses n'est possible que dans des eaux en mouvement. Ces densités de 1,0278 surmontant de plus de cent mètres des densités de 1,0274 vers Terre-Neuve, ou 1,0276 vers le Groenland ne peuvent se maintenir ainsi que par le mouvement. La rotation de la terre entraine vers l'Ouest les eaux polaires descendant vers le Sud et vers l'Est les eaux salées montant au Nord. Ces deux masses cheminent sans se mélanger en conservant un état d'équilibre paradoxal. On voit sur les croquis à droite et à gauche, la progression des eaux polaires avec le flux de surface maximum en 89 et 91, tandis qu'en 89 et 92 le flux de fond plus lourd indique une transgression salée. Nulle part, jusqu'à 200 mètres l'analyse ne décèle l'eau atlantique de salinité supérieure à 35. Les eaux du détroit de Davis jusqu'à cette profondeur sont des eaux de pente. Or nous sommes dans une année de forte marée de salinité, moins importante que celle de 1927 et 1928, mais encore supérieure à la moyenne et au moment du grand flux d'été. On peut donc affirmer que le courant Sud observé dans le détroit de Davis est formé d'eau de pente et n'appartient nullement

[1]) Tableau 1, fig. 5, références se rapportant au Tome II, fasc. 4, Revue des Travaux Office des Pêches.

au Gulf Stream comme le figuraient d'anciennes géographies. Une seule hypothèse est possible et permet de rendre compte du phénomène observé: c'est celle des transgressions chaudes dont nous avons observé certaines modalités à propos des coupures du plateau continental. Nous observons ici le même phénomène en eau libre. Le maximum d'émission se situe au-dessus des plus grands fonds. Le sondeur Marti accuse en effet: 3000, 3360, 3400, 3380 mètres entre les stations 92 et 95. Les fonds décroissent ensuite jusqu'à 2500 mètres (station 97). Le grand flux salé se produit au-dessus du thalweg du détroit; les eaux polaires, adhérentes au fond, sont localisées sur les pentes des talus côtiers et ne dépassent pas à l'Ouest 200 mètres, à l'Est 150 mètres. La tranche d'eau de morue est extrêmement limitée et n'atteint le fond en aucun endroit de la coupe envisagée. Les aires de ponte sont donc nulles à cette époque sur tout ce parcours. Nous quittons en effet Terre-Neuve, où la présence de la morue mûre n'est pas signalée, pour trouver au Groenland une morue au stade 1 à 2 de Hjort, c'est à dire ayant déjà pondu.

2. La situation hydrologique en 1929. On sait que la mer de Baffin et le détroit de Davis sont parcourus par deux courants polaires.

Le courant Labradorien est formé par la fonte des glaces des Smith Sound, Lancaster Sound, Jones Sound. Ce courant de surface, de faible densité, est accéléré par les vents de Nord à Nord-Ouest fréquents au printemps et qui aident à rompre la banquise.

Le deuxième courant, chargé de glaces, provient du Spitzberg et suit la côte Est du Groenland pour contourner le Cap Farvel et remonter ensuite au Nord. En Mai-Juin, il atteint le 74° de latitude et en Juillet-Août, on le trouve au Smith Sound.

Les eaux de pente chassées par les eaux atlantiques, pénètrent dans le détroit de Davis à une profondeur variable suivant leur densité. La présence de ces eaux est signalée par la température plus élevée et la salinité plus forte que l'on remarque en profondeur dans la baie de Baffin et la baie de Disko.

Il y a formation d'eau de morue lorsque la température de 3° à 5° se rencontre sur un fond donné avec une salinité de 33 à 34. Comme à Terre-Neuve, la morue peut se trouver en dehors de ces limites puisque les bornes de son habitat sont de 1°5 à 10° et de 30 à 35 de salinité. Mais c'est dans l'eau de morue que l'on trouvera les grands rassemblements. Suivant l'importance des transgressions chaudes océaniques, c'est à dire de l'avance des eaux atlantiques en été, les eaux de pente, c'est à dire de 33 à 35 de salinité seront refoulées vers le Nord, avec plus ou moins d'intensité, en même temps que le courant polaire décroit de puissance. Aussi bien du côté labradorien que du côté Groenlandais, le débit du courant polaire se manifeste par sa vitesse assez faible: 0,8 à 1 *n* environ, mais surtout dans sa largeur et sa profondeur. Le courant Groenlandais dans la baie de Baffin est beaucoup plus faible que le grand courant labradorien. Il est également moins large et moins profond. Les eaux de pente, plus chaudes, sont appuyées par le mouvement de la terre vers l'Est, puisqu'elles montent au Nord, et elles compriment contre la côte et vers les fjords ce courant froid Groenlandais qu'elles accompagnent parallèlement en montant vers le Nord. La poussée des eaux chaudes est d'autant plus forte que l'on avance dans l'été; son maximum est proche de la fin de septembre

à la latitude de 70 à 72°. Après cela il rétrograde et les situations acquises ne durent guère. La renverse suit immédiatement le maximum d'avance.

Il ne faudra pas perdre de vue qu'au Groenland Occidental les eaux froides, comme les eaux chaudes viennent du Sud et que la transgression estivale chaude produira des effets plus marqués au Nord qu'au Sud, jusqu'à une certaine limite s'entend, c'est à dire aux alentours de la région de Disko.

Dès que la banquise a fondu dans la baie de Baffin et a cessé de produire son effet retardateur, la transgression chaude se fera irrésistiblement et ne sera plus arrêtée que par le refroidissement automnal et par la fonte des icebergs chassés vers le Nord par le courant oriental qui contourne Farvel.

Si donc la source froide au Groenland Occidental pendant l'été est au Sud, il faut s'attendre à trouver des températures de plus en plus élevées en montant vers le Nord jusqu'à Disko et cette considération ne devra pas être perdue de vue par les pêcheurs. En profondeur et même en surface, à partir d'une certaine époque de l'année, les températures seront plus fortes par 68° que par 64°. C'est pourquoi la région de Disko a pris le nom d'Eden du Groenland; c'est pourquoi le banc Fylla, contrairement aux opinions répandues par les premiers pêcheurs, est loin d'être le meilleur pour la pêche. Tout au contraire, à partir d'une certaine date de l'année, il sera beaucoup moins avantageux que d'autres bancs situés plus au nord. Il peut même arriver qu'après avoir passé la ceinture de glaces et d'icebergs qui en été, au début de saison, couvrent une partie du Fylla et s'étendent à l'ouest vers le milieu du détroit, on trouve, plus au nord, une région libre de glaces et où la température des fonds est favorable à la morue. Mais il ne faut pas croire que ce phénomène remarquable se produise tous les ans de la même façon. Lorsque les glaces ont été assez fortes à la latitude de Disko, soit à la côte même, soit simplement au milieu du détroit, il faut un certain temps pour que la transgression chaude rende les eaux habitables à la morue dans les petits fonds côtiers. Il est indispensable de tenir compte de cette observation si l'on veut comprendre pourquoi les bancs du Nord, très favorables certaines années de très bonne heure, le sont beaucoup plus tard l'année suivante. C'est qu'en effet, le processus que nous venons de décrire dépend des phases du conflit de chaque été entre les eaux polaires et les eaux de pente. Il se produira fatalement à un moment où à l'autre, mais il peut être retardé dans son apparition et sa durée peut être singulièrement écourtée par le retour du froid hivernal.

Il importe donc de sonder les eaux centrales du détroit, de suivre la progression des eaux chaudes vers le nord; la morue se déplace avec le flux montant, dans la tranche d'eau favorable; mais il s'en faut que cette tranche parvienne aux fonds de moins de cent mètres, à une latitude donnée, exactement à la même date, chaque été. La liaison, pour le peu qu'on ait pu recueillir de renseignements jusqu'à présent, entre cette progression et le rythme des transgressions atlantiques semble déjà très nette. C'est ainsi qu'en 1925, année de forte transgression froide, l'apparition de l'eau de morue et du poisson semble avoir été assez tardive au Groenland. Nous savons de même que 1908 et 1909 ont été de mauvaises années où le poisson sembla presque inexistant sur les bancs côtiers; or ces années sont bonnes à Terre-Neuve. En 1922, par contre, mauvaise année à Terre-Neuve, la morue est d'une abondance rare au Groenland, nous signale un capi-

taine norvégien de baleinier; enfin depuis 1927 les pêches splendides du Groenland coïncident avec de mauvaises années à Terre-Neuve et avec de fortes transgressions chaudes.

Il y a des modalités même dans ces phases de prospérité et de décadence; c'est ainsi que la situation en 1930, bien que très supérieure à celle de Terre-Neuve est en décroissance par rapport aux trois années précédentes. Il nous semble que la raison doit en être cherchée uniquement dans le régime des eaux; il y a eu retard incontestable dans l'envahissement des petits fonds seuls fréquentés par les pêcheurs, à l'exception de l'expédition du Helder. Il s'en est fallu de plus d'un mois que les phénomènes constatés en 1929 se reproduisissent. Plusieurs navires, arrivés trop tôt, ont dû attendre l'arrivée de l'eau chaude et du poisson.

Il serait d'un intérêt capital de pouvoir suivre au centre du détroit la poussée vers le nord des eaux de pente, puis la conquête progressive des pentes du talus continental par le flot de salinité et de température normale. Il est extrèmement probable que l'on constaterait la présence de la morue en eau profonde dans la tranche d'eau favorable bien avant le moment où elle apparait sur les petits fonds avec l'eau de morue. On saurait ainsi à quelle distance du talus continental et à quelle profondeur se trouve l'eau type sous toutes les latitudes et aux différentes époques de l'année. Il suffirait pour cela de pratiquer des coupes verticales de la surface au fond sous chaque degré de latitude de 60 à 70 et d'une dizaine de milles de la côte à 100 ou 150 milles au large.

Nous ne connaissons même pas la température des eaux profondes aupied des icebergs à la latitude de Farvel. Cependant nous savons qu'en automne toute cette côte se dégage et par conséquent qu'à la fin de chaque année, la température y doit monter d'une façon sensible. Il ne nous parait pas impossible qu'au moment de l'envahissement de la côte par les icebergs, que charrie le courant oriental, alors que les eaux de surface sont très froides, on puisse trouver au-dessous de 200 à 300 mètres des températures favorables à la vie du poisson. Ces eaux, adhérentes au fond, sont peu à peu refoulées vers le large par la descente massive et lente des eaux denses plus froides, par suite de leur contact avec les eaux de fusion, et pendant que la transgression chaude est déjà fortement commencée vers le milieu du détroit, il y a régression des eaux de pente devant les eaux polaires dans toute la région de 60 à 65° précédemment conquise. L'extension des eaux polaires vers le large peut fort bien passer par un maximum, variable avec la latitude et avec les années, de telle façon que, normalement, les fonds du nord cèdent les premiers à la poussée des eaux chaudes, et la région de Farvel, la dernière. Mais il est bien évident que ce conflit diffère essentiellement d'une année à l'autre dans ses modalités. Il en résulte que si le point des bancs côtiers atteint le premier par l'eau de morue est certainement au Nord de Farvel, il n'est pas toujours forcément Disko, et il convient de tâter l'eau, du Sud au Nord, pour s'en assurer.

Enfin, il est encore plus important pour des pêcheurs de ne pas se borner à une région de profondeur déterminée et de s'outiller pour travailler le cas échéant à des profondeurs quelconques jusqu'à 7 et 800 mètres, s'il le faut, si les petits fonds sont momentanément déserts, parce que l'eau y est encore trop froide.

Nous indiquons dans les figures 8 à 11 et le tableau II[1]) la position d'un certain nombre de stations et différentes coupes qui permettent de voir quelle était la situation à la fin de juillet 1929 sous les latitudes de 63°30′ à 64°30′.

On constate que les eaux froides sont plus apparentes en surface à hauteur du Banc Fylla. Les eaux chaudes exécutent des poussées transversales par toutes les coupures du plateau (toujours à droite) en venant du large.

3. Le Banc Fylla. La mission de 1929 de l'Office des Pêches au Groenland comportait l'établissement d'une carte des pêches du Banc Fylla. Cette carte fut établie en coordonnées polaires par relèvements et distances du Hjortetakken, la triangulation générale de la côte occidentale du Groenland semblant sujette à caution. C'est une carte en couleurs représentant par des teintes différentes les diverses natures de fond. Les sondes sont relevées par des isobathes de 10 en 10 mètres. Un certain nombre de fiches relatives à la faune sédentaire a permis de donner une première approximation de la situation.

Ce banc s'est révélé comme une table granitique d'une profondeur moyenne de 60 à 65 mètres relevée sur son bord oriental et inclinée en pente douce vers l'Ouest. Elle mesure 40 milles de long du Nord au Sud, de 63°35′ à 64°15′ et 15 milles de largeur moyenne de 52°20′ à 53°02′. Elle est entièrement recouverte de cailloux et de sables quartzeux piqué de noir avec quelques affleurements de roches, principalement par 52°35′, le long d'une arête que soulignent des côtes de 34 à 39 mètres, au dessus de fonds de 43 à 45 mètres. A 80 mètres de profondeur vers l'Ouest, & 50 mètres à l'est, la table est coupée par un effondrement brusque, qui fait passer la sonde à 300 mètres en moins d'un mille, sur presque tout son pourtour, sauf à l'Est, où un pédoncule de 5 milles de large la relie aux fonds côtiers, dont elle est séparée, partout ailleurs, par un fossé profond de 250 à 300 mètres au Nord, et de plus de 300 mètres au Sud de son isthme d'attache. Çà et là, les fonds sableux sont parsemés de cailloux granitiques, feldspath et quartz, tantôt roulés, tantôt rugueux suivant l'époque plus ou moins ancienne où les icebergs les ont déposés au passage. Ces cailloux ont toutes les tailles depuis le simple galet jusqu'au bloc de 50 à 100 kgs, jusqu'aux blocs erratiques qui provoquent des sondes inférieures de 5 à 10 mètres à celles du plan sur lequel ils sont posés.

Sur cette base sableuse s'étalent des plaques de madrépores, de coquillages et surtout une quantité considérable de balanes pourries ou vivantes que l'on a rangé sur la carte sous le nom de coq. ou coq.br. En réalité cette dénomination cache très souvent la formation de solides bancs calcaires dont la drague brise au passages de forts mœllons quand elle tombe sur une arête qui consent à céder. Il est inutile de souligner la difficulté que de pareils fonds entrainent pour le chalutage. Par contre, après avoir franchi une banquette de 8 mètres de hauteur qui sépare les fonds de 45 mètres des fonds de 53, et s'étend sur 15 milles du Nord au Sud, par 52°13′ de longitude, on arrive sur une terrasse de 53 à 65 mètres de fond, large de 4 milles, longue de 10 à 12, qui est praticable aux engins traînants avec quelques précautions. Mais l'usure du matériel y demeure

[1]) Tome II, fasc. 4, Revue des Travaux de l'Office des Pêches.

rapide, si les grosses avaries sont rares, parce que les balanes grignottent les filets. Plus au Sud, par 63°40′ à 63°45′ on peut signaler de même un ilôt de 68 à 72 mètres de fond qui est possible. Partout ailleurs le chalut ne doit agir qu'avec une extrême circonspection.

Ce banc est le paradis du pêcheur sédentaire. On y trouve de riches »fonds vivants«, crabes, holothuries, vers, éponges, bolténias et pétoncles. Le bulot s'y rencontre, mais insuffisant pour former une boëtte d'occasion. Ce riche terrain, mélangé de sable plein de lançons est un attrait pour la morue.

Au Sud du Banc Fylla, le banc Fiskernaes, au Nord le Banc Lille Hellefiske, semblent très analogues tant au point de vue des sondes, de la nature des fonds, que de la situation hydrologique au même moment. Nous avons commencé au Fiskernaes une rectification de la carte et constaté que les deux bancs signalés comme coupés l'un de l'autre par une forte dépression, sont en réalité soudés l'un à l'autre. Mêmes fonds qu'au Fylla. Deux régions y paraissent chalutables en prenant des précautions: la première de 63°05′ à 63°10′ dans les fonds de 80 à 85 mètres, la deuxième dans l'angle NW entre 63°20′ et 63°23′ de latitude, 52°30′ à 52°40′ de longitude, fonds de 100 à 110 mètres, vase ou sables vasards.

Mais il faut tenir compte du fait que les températures étant en règle générale plus froides au Sud qu'au Nord, le Fiskernaes sera visité plus tardivement que le Banc Fylla par l'eau de morue. La différence était de un degré (2°7 au lieu de 3°7) en juillet 1929.

4. La pêche au Banc Fylla en 1929. En 1929 avant la publication des résultats de l'enquête entreprise par l'Office des Pêches sur les Bancs du Groenland, un premier essai fut tenté par quelques pêcheurs français, attirés par la nouvelle des riches captures effectuées depuis 1925 par les Norvégiens, les Danois des îles Féroé, et deux barques de Paimpol qui passèrent en deuxième pêche de l'Islande au Groenland.

On trouvait donc en juillet sur ces bancs

1° les habitués, à savoir une douzaine de barques, en général à moteur, du port de 100 à 200 tonneaux, gréés en dundées et dont l'équipage est d'une vingtaine d'hommes. Ces barques pêchent du bord à la ligne à main, comme en Islande. Certaines ont adopté un mode un peu différent; les jours de beau temps ou de calme elles mettent à l'eau trois doris montés chacun par trois hommes qui s'écartent à quelques centaines de mètres du bord et qui permettent de diminuer de la sorte la trop grande densité des lignes sur un seul point. Trois de ces navires sont d'anciens Terre-Neuves français abandonnés par leurs armateurs, comme de trop petite taille, et qui réussissent fort bien dans ce nouveau métier. A côté de ces navires et exécutant le même travail, à l'exception près des doris satellites qu'elles ne possèdent pas, on remarque deux goélettes islandaises de France et un ancien trois mats du Banc transformé à moteur. Tous ces navires, qui pêchent à la ligne à main, se plaignent de ce que la situation est moins bonne qu'en 1927 et 28. Ils feront cependant leur plein, mais avec un certain retard.

A côté d'eux, se trouve un navire d'un nouveau genre, le Zaspiakbat, voilier français en fer, à moteur, de 800 tonnes, qui va capturer en 56 jours de pêche 500 tonneaux de morue. Cette fois, c'est le procédé classique de Terre-Neuve, la palangre, mouillée

par des doris, qu'on emploie; ce procédé est une innovation au Groenland. La boëtte employée, du hareng congelé, fait merveille. Il est nécessaire que cette boëtte soit de premier choix, malgré la voracité légendaire de la morue; il est certain, on l'a essayé, que le hareng salé ou mal congelé est loin de donner les mêmes résultats.

Les captures faites par le Zaspiakbat appellent une modification des procédés employés par les autres pêcheurs. Le personnel double de celui des goélettes fait journellement une pêche quadruple pour une dépense supplémentaire de matériel qui est de peu d'importance. Nous verrons cependant en 1930 que la ligne à main ne doit pas être abandonnée.

La morue du banc Fylla est de la morue débarassée de sa rogue depuis un mois environ au milieu de juillet. Elle a donc dû frayer en fin mai, début de juin. Où? Mystère. Nous ignorons complètement cette question. Les usagers du Groenland prétendent que la morue fraie dans les fjords. C'est possible. Il est certain que certaines espèces très rouges, qui sont en train de muer pour revêtir la livrée jaune des fonds de sable peuvent venir des roches de la côte. Mais toutes ne sont pas du même genre et il est certain d'autre part que la morue va monter vers le Nord, puis se rapprocher des fjords en fin de saison. Il est donc plus que probable qu'une bonne partie au moins de cette morue, si elle émigre dans les fjords, en sentant les eaux se refroidir, doit repasser au large en utilisant les coulées profondes qui séparent les bancs et font communiquer le centre du détroit avec la dépression côtière que nous avons signalée à propos du Banc Fylla, dépression qui suit tout le rivage du Sud au Nord. Nous sommes donc convaincu que la plus grande partie de ces morues hiverne ou au moins stationne au printemps dans les grands fonds du large et y fraie. Ce n'est que plus tard qu'elle s'avance sur les petits fonds. Mais cette explication est bien problématique. Elle se base uniquement sur le mouvement général d'été de la morue qui avance de la haute mer vers le rivage à mesure que le courant froid diminue d'amplitude et sur le fait que l'expédition du Helder, n'ayant pas pêché au début de saison sur les petits fonds a retrouvé le flétan tout au moins par 8 et 900 mètres au large des bancs.

La morue du Banc Fylla est de la morue en plaine, c'est à dire dispersée. Mais elle est d'une abondance extraordinaire et les captures même pour un chalutier sont intéressantes. Pour un cordier elles sont prodigieuses. Le Zaspiakbat en 1919 changeait de place lorsque sa pêche, à douze doris, devenait inférieure à 200 quintaux par jour. Il retrouvait immédiatement, à quelques milles, des prises de 300 qx. Chose incroyable à Terre-Neuve, les ébrègues, têtes de morues, tripailles, constituaient dans les fonds, par lesquels il avait passé, un appât pour attirer la morue et il retrouvait dans les estomacs de ces poissons affamés des débris à demi putréfiés qui auraient fait fuir le poisson de Terre-Neuve.

L'expérience a donc été faite; pour les cordiers au moins, les bancs du Groenland sont susceptibles de fournir des éléments de captures d'autant plus intéressants qu'il s'agit surtout des mois d'été pendant lesquels, même en année normale, le poisson se raréfie à Terre-Neuve. Nous avons vu que le régime hydrologique des eaux polaires et atlantiques dont le conflit détermine ici ou là la formation de l'eau de morue, entraine pour une région donnée des vicissitudes dont on commence à sentir à peu près les grandes

lignes. On peut comparer ce qui se passe à Terre-Neuve, avec un certain décalage, au phénomène analogue de la côte Norvégienne. Les mêmes effets doivent être produits par les mêmes causes. L'amplitude des transgressions chaudes dans l'Est et le Nord-Est de l'Océan détermine là également des variations de températures qui peuvent devenir nuisibles à la bonne habitabilité des eaux côtières. Et lorsque les Norvégiens, à la recherche du poisson promènent leurs engins de pêche sur la côte Mourmane, à l'Ile aux Ours ou au Spitzberg, pendant l'été, que font-ils, si ce n'est de répéter le mouvement des pêcheurs de la côte américaine qui ne trouvant plus dans leurs parages accoutumés les eaux polaires dont ils ont besoin pour pêcher, vont les rechercher jusqu'aux parages lointains du Groenland?

Mais il ne faut pas imaginer que l'on ait fait une découverte sensationelle de nouveaux terrains de pêche, riches, parce que non exploités, et que cette situation va durer pendant que les fonds de la région abandonnée se repeupleront. En réalité, les fonds classiques ne sont pas dépeuplés; ils sont momentanément inhabitables et voilà le raison du départ de la grande masse du poisson. Ce n'est pas le poisson qui a changé d'habitat; c'est l'habitat qui a changé de place. La situation ne durera pas toujours et il faudra veiller avec attention les signes de décroissance de la pêche pour revenir en temps opportun aux endroits abandonnés.

Quoi qu'il en soit, la découverte du poisson dans ces fonds nouveaux est riche de conséquences car elle assure les armateurs de trouver le remède à la situation déficitaire, trop longtemps subie, d'une région donnée. Il suffira en pareil cas d'émigrer vers l'origine des eaux polaires pour retrouver pendant les années de vaches maigres le poisson absent ailleurs. Le Groenland sera donc un excellent terrain de pêche de complément d'une mauvaise campagne de Terre-Neuve.

5. Le Banc Store Hellefiske. En 1929, il y avait déjà trois ans que des pêcheurs français venaient au Groenland[1]). Régulièrement ils allaient au Banc Fylla, à telles enseignes que le Groenland devenait le Fylla, exactement comme à Terre-Neuve, pour certains pêcheurs, il n'est pas de salut endehors du Platier.

Si les renseignements sur le Banc Fylla sont assez peu abondants, par contre ils manquaient totalement à l'époque, pour les bancs situés plus au nord. On savait seulement que lors de l'expédition Hjort de 1924 on avait trouvé du poisson sur le Banc Lille Hellefiske, mais bien que les températures en août, jusqu'à Disko, se soient trouvées favorables (aux environs de 4°), il semblerait que la mission envoyée, pour une raison on une autre n'ait pas trouvé le poisson en cet endroit. Cette constatation ayant été renouvelée en 1925 il semblait qu'en conséquence on pouvait affirmer que la morue disparait au nord d'Holsteinsborg. Nous ignorions encore à ce moment les communications faites par Mr. Baldersheim sur les résultats obtenus en 1927 et 1928 par l'entreprise du Helder.

D'autre part, les pessimistes n'avaient pas manqué d'accompagner le départ des navires de réflexions décourageantes. Les »renseignés« à Halifax comme ailleurs ne man-

[1]) deux goélettes de Paimpol.

quaient pas d'affirmer que les fonds du Groenland n'étaient par chalutables; le tout serait de savoir de quels fonds ils parlaient. Le Banc Fylla en effet leur donnait raison, bien que les premiers chalutiers français envoyés au Groenland au début de juin 1925, s'ils n'avaient pas trouvé de poisson, n'avaient pas jugé les fonds plus durs qu'en Islande par exemple, bien qu'ils aient pêché dans les parages du Banc Fylla.

Pour les deux premiers chalutiers français qui s'étaient aventurés sur les lieux en 1929, la situation était lamentable. Pendant que le Zaspiakbat à côté d'eux faisait 250 quintaux de pêche moyenne par jour, c'est à peine s'ils obtenaient 75 quintaux et au prix d'avaries répétées qui épuisaient le matériel de rechange emporté.

Ayant passé sur le Van de Walle, au moment du départ de la Ste Jeanne d'Arc pour son charbonnage, je n'eus pas de peine à décider le capitaine, encore hésitant, à tenter fortune sur les bancs du Nord, qui, si l'on s'en rapportait aux températures notées en 1924 par Mr. Hjort, devait être couvert d'eau de morue à l'époque où nous étions arrivés (fin de juillet).

Dès que l'on a quitté le Banc Fylla, on entre dans une région dont la carte à petit point ne porte que des sondes clairsemées. C'était cependant dans ce demi inconnu que l'on devait trouver une surface propice aux engins traînants. Fort heureusement, on ne s'arrêta pas au Banc Lille Hellefiske, dont les fonds sont variés, souvent très durs, et qui demanderait, avant d'être tenté, une sérieuse exploration hydrographique. Le Van de Walle dépassa le cercle polaire et s'arrêta par 67°30′ dans les fonds de 60 à 70 mètres. La drague rapporta du sable fin piqué de noir que l'on ne trouve guère que sur de vastes étendues. Nos prévisions se trouvaient justifiées. Il nous avait paru probable en effet que les environs de Disko étant la région où les courants polaires du nord et du sud s'affrontent pendant une grande partie de l'année, il devait y avoir là un dépôt de sédiments fins qui permettait le chalutage en colmatant les aspérités rocheuses des bancs, tandis qu'au Banc Fylla et sur les bancs du sud, la persistance des courants dirigés vers le nord devaient laver les surfaces et ne laisser en place que les blocs et les cailloux assez lourds. D'autre part, le thermomètre au fond accusait 3°7, c'est à dire présence de l'eau de morue.

Les résultats furent conformes aux probabilités escomptées. Les fonds étaient parfaitement chalutables à la condition d'opérer comme au Banc Fylla, c'est à dire avec un matériel de dimensions réduites et considérablement allégé par des boules, des élévateurs etc. La morue abondait et dès le premier jour la moyenne de la pêche se fixa à 300 quintaux.

Pendant le mois d'août, le Van de Walle resta seul sur le Banc Store Hellefiske et explora une surface de 40 milles de long sur 10 de large en se maintenant dans les fonds de plus de 50 mètres sans dépasser 70 mètres entre 67°10′ et 67°50′.

Le temps se montra clément; plusieurs dépressions passèrent au Cap Farvel, mais se firent peu sentir à cette distance. Il ne faut pas oublier que le Groenland se trouve dans le grand anticyclone du Nord Amérique et que les tempêtes, en été y sont très rares:

Il a été malheureusement impossible faute de navire à notre entière disposition d'établir une carte des fonds du Banc Store Hellefiske.

La situation hydrologique se maintint pendant l'automne. Les chalutiers restèrent

jusqu'au 10 novembre, sans perdre le poisson et furent chassés par la rigueur de la température et la longueur des nuits.

Le poisson s'éleva peu à peu vers les petits fonds. On le pêcha jusque par les fonds de 30 mètres. Le maximum semble avoir eu lieu en septembre. A cette époque certains chalutiers avaient à peine le temps de lancer leur chalut dont ils n'accrochaient même pas le chien. Au bout d'un quart d'heure, ils le relevaient plein. La morue était abondante aussi bien en surface qu'entre deux eaux ou qu'au fond; elle se nourrissait particulièrement de petits crustacés qui foisonnaient. Elle était à ce moment à quelques quinze milles de la côte et semblait gagner la terre.

Avertis par la TSF, une quinzaine de chalutiers quittèrent les bancs de Terre-Neuve et se joignirent aux navires déjà montés au Groenland. Les résultats obtenus ont prouvé qu'à cette époque, et jusqu'en novembre, l'abondance du poisson était de quatre à cinq fois supérieure à ce qu'on pouvait constater dans les meilleures régions de Terre-Neuve.

L'expérience était donc concluante: le Groenland se présente en été, comme un excellent terrain de complément pour la pêche de Terre-Neuve.

III. Recherches faites au Groenland en 1930.

En 1930 trois chalutiers ayant quitté Terre-Neuve le 22 mai, firent route pour le Groenland, où ils arrivèrent du 30 mai aux premiers jour de juin. Ils parcoururent en vain les petits fonds du Banc Fylla au Banc Store Hellefiske sans trouver de poisson d'aucune espèce.

D'après les renseignements que nous avons obtenus la température à cette époque était stabilisée entre 1° et 1°5, entre 50 et 100 mètres, du Banc Fylla au Banc Store Hellefiske.

Cette température se maintint par 67° de latitude nord jusqu'au 16 juin. Naturellement la pêche était complètement nulle. Il n'y avait pour ainsi dire pas de poisson. Les chalutiers tentèrent les fonds de 140 mètres par $L = 67°50'$ et $G = 54°30'$ sans résultats malgré 50 minutes de trainage. Même insuccès, le 3 juin, par 150 mètres (67° et 56°). Si l'on se rapproche de terre, la température descend à 1°. Absence totale de poisson. Les grands fonds du large, supérieurs à 200 mètres, n'ont pas été tentés. Le réchauffement des eaux n'est pas commencé. Des icebergs couvrent tout le nord du Banc Store Hellefiske. La banquise disjointe ne s'est pas encore rétractée vers la terre de Baffin. Les glaces encombrent tout le détroit jusqu'aux fonds de 200 mètres du Banc. Le 17 juin, après ces tentatives infructueuses, tous les chalutiers montés au Groenland sont rassemblés sur les petits fonds du Banc Fylla, où ils attendent l'arrivée de l'eau favorable.

Le Zaspiakbat arrive à ce moment. Sa première marée est satisfaisante. C'est entre le 18 et le 20 juin que le premier réchauffement de la saison commence à se faire sentir au Banc Fylla. Le 24 juin, sur ce même banc, par $L = 63°50'$ et $G = 52°50'$, je constate que la température à 60 mètres atteint 2°3. Une quantité considérable de morues vient d'envahir les petits fonds depuis la veille. Six jours avant, il n'y avait absolument rien.

Il est difficile de ne pas remarquer la coïncidence absolue de l'arrivée du poisson sur les petits fonds avec la vague plus chaude.

Comme en 1929, le poisson est au stade 2 c'est à dire débarassé de son frai depuis plus d'un mois. Où a-t-il frayé? Nous l'ignorons. Je ne crois cependant pas que ce poisson vienne des fjords, car plus on avance vers l'est, plus l'eau est froide. En outre, ce poisson ne porte pas les signes caractéristiques de la morue de roche remarqués l'année dernière, en grand nombre, au milieu de la morue de sable. Celle-ci est jaune et brun clair; c'est de la morue de sable ou de vase. Je suis convaincu qu'elle provient des grands fonds et je regrette de n'avoir pas à ma disposition le moyen de m'en assurer.

Le Banc Fylla produisant, comme en 1929, ses ravages inévitables sur le matériel, le chalutier qui me porte, découragé, ne tarde pas à quitter les lieux pour remonter vers le Nord. Le 25 juin, je constate à 90 mètres ($L = 65°30'$; $G = 55°$) une température de 1°2. 60 milles plus loin, par 180 mètres, dans la fosse séparant le Helder et le Banc Store Hellefiske, il y a 1°6; enfin à 60 mètres par $L = 67°25'$, sur le Banc Store Hellefiske, on ne trouve que 1°2, c'est à dire une température analogue à celle qu'avait constatée le chalutier qui avait exploré les parages un mois plus tôt. L'eau chaude n'a pas encore fait son apparition dans la région.

La situation se présente donc comme absolument différente de celle que l'on signalait en 1928 (température de 3° à la lisière sud du Banc Store Hellefiske au début de juin). Il y a certainement six bonnes semaines de retard dans l'arrivée de la transgression chaude sous cette latitude, et à cette profondeur. Naturellement, le Banc Store Hellefiske est dépourvu de poisson. Le navire qui me portait, n'osant pas s'aventurer à tâter les grands fonds de l'Ouest, qui, j'en ai la conviction, auraient montré la présence du poisson dès qu'on aurait atteint l'isotherme de 3°, allait redescendre au Banc Fylla, faute de pêche, malgré la certitude d'y faire des avaries.

Brusquement le 28 juin, la température passa dans les fonds de 95 mètres, de 1°2 à 1°6, et dans les fonds de 60 mètres, de 1°9 à 2°1. Le surlendemain, la température atteignait 2°6 à 60 mètres. D'un quart de palanquée au trait d'une heure (500 kgs de poisson frais), on passait, en deux jours, à une palanquée au minimum (deux tonnes de poisson frais), pendant la même durée de traînage.

D'autres chalutiers, lassés du Banc Fylla pour les mêmes raisons, arrivaient à ce moment et commençaient à faire par fonds de 50 mètres, des captures moyennes journalières de 200 quintaux.

Au même moment, les voiliers remontaient vers le Nord, s'installaient en partie sur le Helder, en partie sur le Banc Lille Hellefiske, montaient même progressivement sur le Banc Store Hellefiske et accusaient de 100 à 300 quintaux suivant l'état du temps.

Somme toute, dès la deuxième semaine de juillet, la situation de 1929 se reproduisait. Il semble bien toutefois qu'il y ait eu un retard appréciable. Nous avons signalé 6 semaines sur 1928; il nous semble possible qu'il y ait eu 3 bonnes semaines de retard sur 1929.

Mais comme l'année dernière, l'arrivée de l'eau de morue (plus de 3°), a entrainé sur des bancs, absolument déserts jusqu'à ce que les fonds atteignent la température de 2°5, un afflux considérable de morue. Comme l'an dernier ce poisson est débarassé de

sa rogue, il est avide de nourriture et s'il accompagne ou précède de très près la vague de 3°, il est susceptible, le cas échéant de s'en écarter légèrement à la recherche de sa nourriture. C'est pourquoi on le trouve généralement en quantité satisfaisante pour la pêche dès que la température dépasse 2°5, mais de 2°5 à 2°, il est très rare et au-dessous de 2°, c'est absolument par hasard qu'on réussit aussi bien aux cordes qu'au chalut, à en capturer quelques spécimens.

Cette situation, une fois établie, s'est maintenue. En août, à 50 mètres de profondeur on observe les températures suivantes:

Lat.	Long.	Temp.			
57°49′	52°02′	4°6			
59°25′	52°02′	8°4			
60°50′	52°02′	2°3			
61°55′	52°02′	5°8			
63°50′	52°35′	3°5			
64°00′	52°45′	2°8	64°38′	52°33′	2°6
65°54′	54°00′	2°9			
66°18′	54°00′	4°4			
67°24′	54°44′	3°9			
68°06′	55°00′	4°4			
67°10′	54°28′	3°8			

On voit que la vague chaude ne suit pas une ligne parallèle à la côte; elle pousse vers la terre des flèches d'importance différente selon la résistance du courant polaire adhérent au rivage. D'une façon générale, le banc Fylla (latitude 64°) est plus froid que le Banc Helder (latitude 66°), et que le Banc Store Hellefiske (latitude 67° à 68°). La situation s'est donc rétablie et la pêche sera bonne pendant les mois d'août, septembre et octobre. Les chalutiers ne quitteront pas le Banc Store Hellefiske et se contenteront d'explorer suivant les passages de morue allant du Sud vers le Nord et de l'Ouest vers l'Est, les petits fonds de 70 à 35 mètres entre les latitudes 67°30′ et 68°05′ du méridien 55 au méridien 54.

Les 45 chalutiers français du Banc de Terre-Neuve ont déserté leurs terrains de pêche coutumiers où la pêche est absolument nulle pour le Groenland.

17 voiliers sans moteurs, 3 navires nouveaux à moteurs, deux cargos à vapeur, armés de doris et pêchant aux lignes de fond, ont cherché fortune du Banc Fylla au Banc Store Hellefiske. On commence à ne plus considérer le premier banc comme unique en son genre; tout au contraire le Banc Helder et le Banc Store Hellefiske apparaissent comme particulièrement favorables et riches.

Après des débuts satisfaisants en juin au Banc Fylla, le poisson a levé. Les lignes de fond ne donnent plus, pendant que les pêcheurs à la ligne à main, dundées des Féroé, goélettes de Paimpol, continuent à faire de bonnes prises. Les cordiers quittent le Banc Fylla dès la première semaine de juillet et viennent s'établir au Banc Helder, puis peu à peu au Banc Store Hellefiske.

Les cordiers pêchent en doris, comme à Terre-Neuve. Ils éprouvent cependant certaines difficultés que l'expérience leur permettra d'éliminer dans une campagne sui-

vante: d'abord le matériel de Terre-Neuve est trop fin; les lignes sont faibles, les orins et ancres sont insuffisants. Le poisson est beaucoup plus vif qu'à Terre-Neuve et l'on constate fréquemment, dans les captures de chalutiers, que des morues sont prises avec un hameçon français dans la gueule. Jusqu'au moment de l'arrivée des cordiers dans les eaux du Banc Store Hellefiske, ce résultat nous renseignera sur les mouvements du poisson. Il est évident, d'après ce marquage de fortune, que la morue qui apparait au Banc Store Hellefiske, monte du sud, évidemment avec la tranche d'eau favorable. En même temps, cet arrachement des avançons des lignes de cordiers nous montre qu'il faut renforcer le matériel.

Les avançons ne sont pas seuls arrachés. Fréquemment, en relevant leurs cordes, les pêcheurs constatent que les lignes elles-mêmes sont rompues. Ils accusent le courant d'être l'auteur de ces dégâts. Plus tard, ils s'aviseront que le coupable peut fort bien être la morue, trop abondante sur les cordes et qui en se débattant finit par rompre les amarrages. L'habitude de la pêche de Terre-Neuve de tendre jusqu'à 30 pièces de 133 mètres et de les laisser toute une nuit dans l'eau, n'est pas justifiée au Groenland. Il convient au contraire de faire de courts »tantis« de 5 à 8 pièces et de les visiter fréquemment: toutes les six heures par exemple.

La boëtte employée a été à peu près indifférente. A l'exception du hareng congelé, de très bonne qualité, qui reste la boëtte de choix, on peut boëtter avec des ébrègues, des chats, du flétan etc., tout est bon. Mais la supériorité du hareng congelé assure une prime incontestable aux navires munis d'une installation frigorifique assurant la conservation de la boëtte fraîche.

Il en résulte que les navires qui sont les meilleurs pour la pêche au Groenland, sont les plus grands, les plus modernes, d'abord les voiliers à moteur dont on peut augmenter la taille sans limite; les grands voiliers de 2 et 3000 tonnes conviendraient parfaitement à ce genre de pêche. Les vapeurs, anciens cargos aménagés sont parfaits. Ils ont tous les avantages, confort et installations très supérieurs, grande facilité de mouvements à peu de distance et en laissant les feux bas, de façon à réduire le plus possible la consommation de combustible.

Le remplacement des doris à bras par des doris à moteurs choque encore trop les habitudes pour être accepté du premier coup. Cependant on y vient; il est incontestable que cela facilite les mouvements. C'est une transformation de matériel qui se fera partout dans les années qui viennent.

Les résultats obtenus, malgré l'imprévoyance des premiers armement sont des plus satisfaisants. Les premiers navires rentrés accusaient une majoration de 50 % sur la pêche à Terre-Neuve. Mais au fur et à mesure que les rentrées se faisaient, les différences s'accusaient encore. On peut compter que le passage de Terre-Neuve au Groenland comme il vient d'être réalisé, en cours de campagne a rapporté à ceux qui l'ont tenté, une augmentation de rendement de 80 à 100 %[1]) sur le rendement individuel des pêcheurs de Terre-Neuve. Pour un début, il est extrèmement remarquable, car il est certain qu'il y a toute une adaptation nécessaire avant de pouvoir comparer d'une façon définitive les résultats.

[1]) Rendement *individuel* moyen en 1930—Terre neuve; 74 quintaux; Groenland: 147 quintaux.

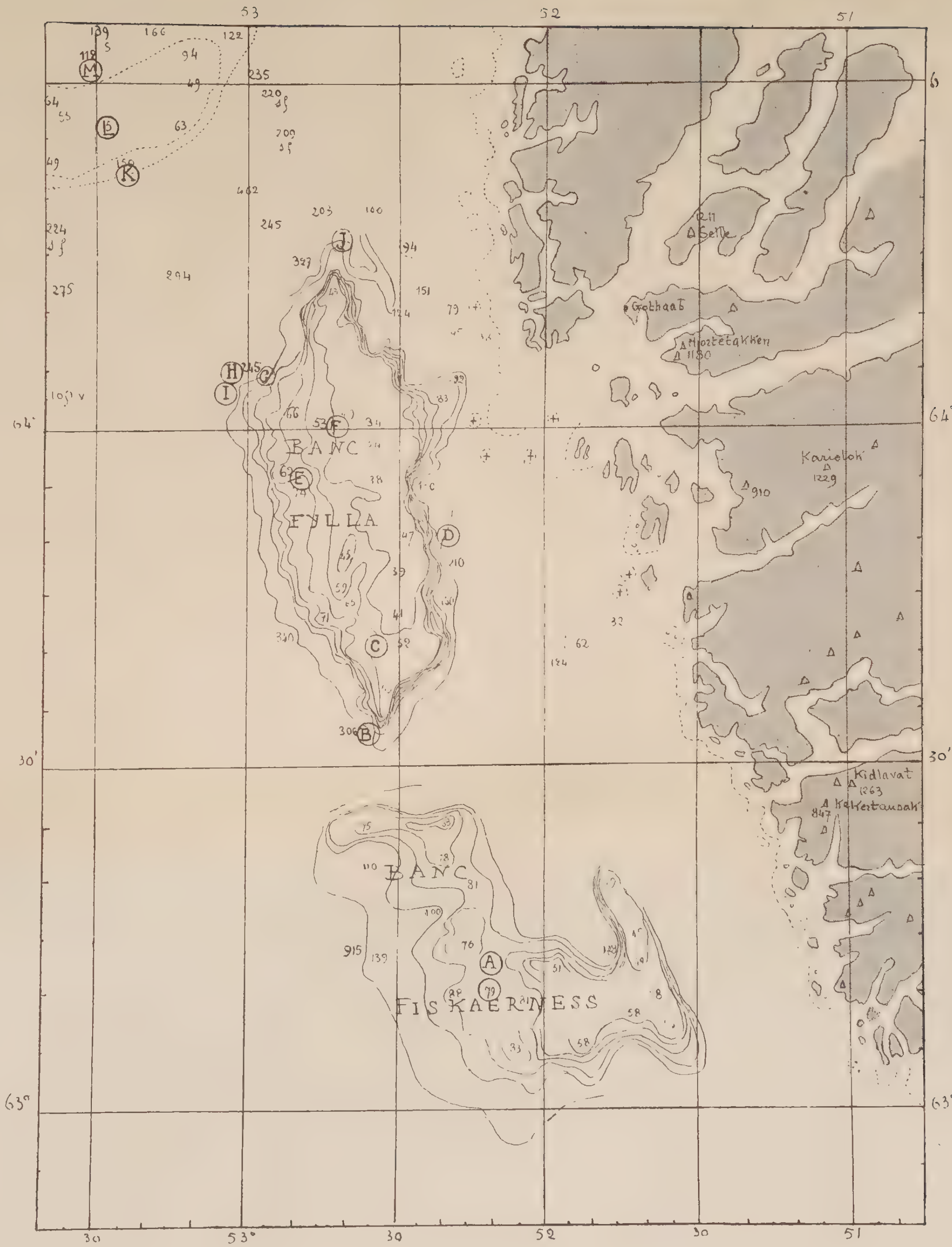
C'est ainsi, par exemple que les cordiers ayant quitté le banc Fylla pour remonter plus au nord, découvrirent pendant une quinzaine de jours, que la morue, absente du fond était extrèmement nombreuse entre deux eaux et jusqu'en surface. La ligne à main, en doris, à la manière de la pêche des Portugais, eût fait merveille dans ces conditions, mais les navires ne possédaient pas de lignes à main. On tenta de »faucher« la morue. Mais on ne possédait pas de faux; on se servait de turluttes à encornet. Cependant le poisson foisonnait à tel point que certain navire signale avoir capturé 3000 morues dans une journée par ce procédé. Si l'on se représente le nombre de morues manquées par ce moyen avant d'arriver en surface, on se rend compte aisément que si le poisson faisait défaut au fond, il existait en tous cas entre deux eaux. Il est donc nécessaire d'être pourvu, avant de partir, du matériel qui peut être utile le cas échéant.

Ces cordiers ont pêché sans difficulté jusqu'à la mi-octobre. Il parait donc bien démontré maintenant que, à la condition de s'outiller convenablement, lorsque la campagne de Terre-Neuve s'annoncera comme mauvaise, il sera possible de passer au Groenland et d'y faire encore une pêche très satisfaisante. Le Groenland peut donc bien être considéré comme la zône naturelle de la pêche de complément des mauvaises années de Terre-Neuve.

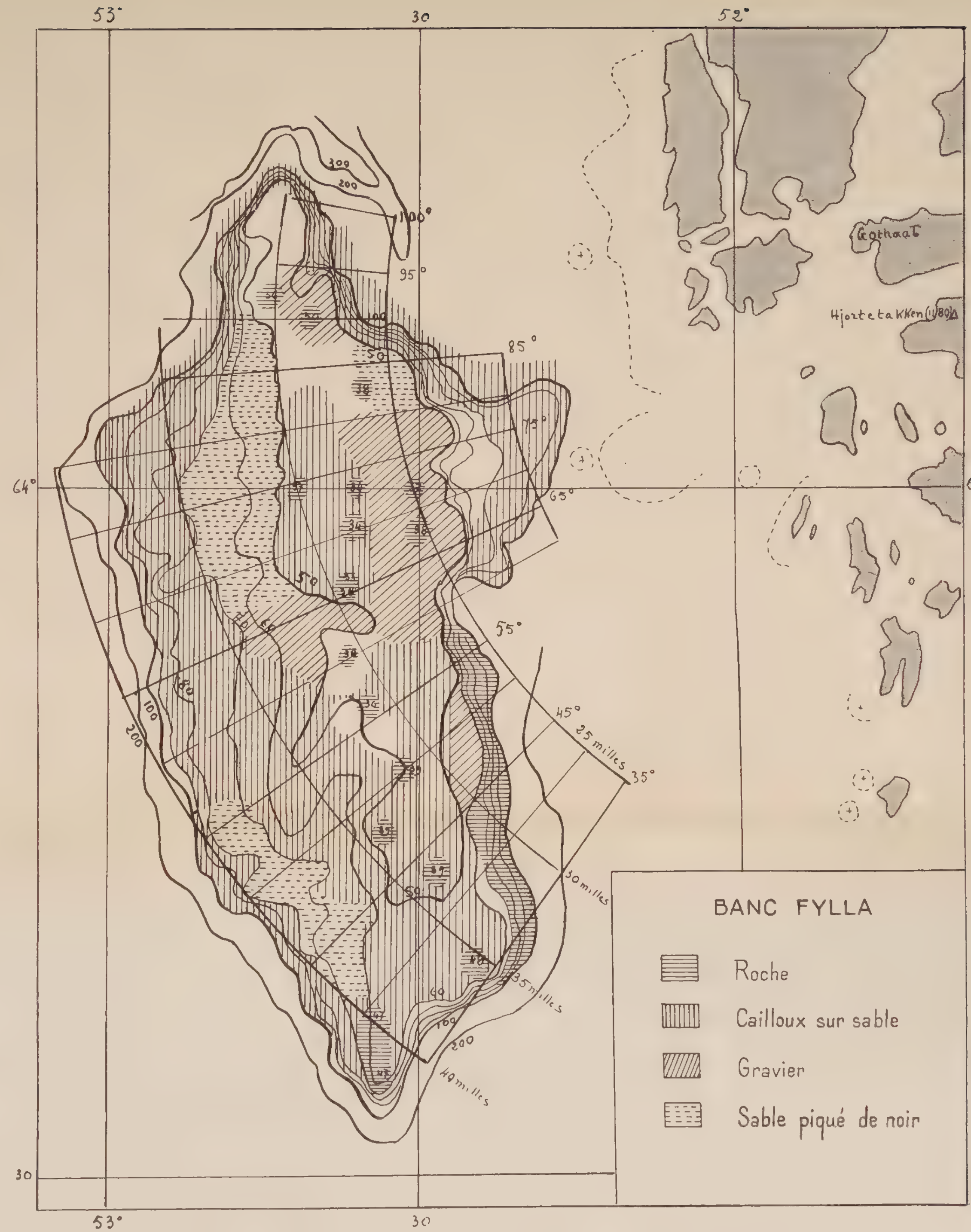
Planche I

LABRADOR
CANADA
RIVIERE ST LAURENT
ANTICOSTI
GOLFE ST LAURENT
ILE DE TERRE-NEUVE
Baie de Bonavista
Détroit de Belle Isle
Iles de la Madeleine
Détroit de Cabot
Fiord de l'Ermitage
Baie de Plaisance
Bassin de Plaisance
Chenal Laurentien
Banc de St Pierre
Banc à Vert
Chenal du Fletan
Chenal de l'Eglefin
Banc de la Baleine
Chenal d'Avalon
GRAND BANC DE TERRE-NEUVE
Bassin du Nord
Bassin du Sud
le Platier
Queue du Grand Banc
Bonnet Flamand
Baie du Melange
Banquereau
Banc de Misaine
Banc Canso
Bras d'Artimon
Middle Ground
I. de Sable
Banc de l'Ile de Sable
Accore des Goelettes
Fosse de Halifax
Banc Sambro
Banc Emerald
Bras de la Have
Bras Roseway
Bn Brown
Baie de Fundy
NOUVELLE ÉCOSSE
GOLFE DU MAINE
Bassin Fundien
Chenal Fundien
Banc George
Nantucket Shoals
C. Cod
60° Ouest de Greenwich

Planche II



53
52
51
6
64°
30'
63°
30
53°
30
52
30
51
Gothaab
Selle
Hjortetakken
1180
Kaerlok
1229
910
Kidlavat
1263
Kekertausak
847
BANC
FYLLA
BANC
FISKAERNESS


BANC FYLLA
Roche
Cailloux sur sable
Gravier
Sable piqué de noir
Gothaab
Hjortetakken (1180)
53°
52°
30
64°
64
25 milles
30 milles
35 milles
40 milles
100°
95°
85°
75°
65°
55°
45°
35°
300
200
100

III

SUMMARY OF THE DANISH MARKING EXPERIMENTS ON COD, 1904–1929, AT THE FAROES, ICELAND AND GREENLAND

BY

JOHS. SCHMIDT

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I. Introduction.

In the years since 1904 the Danish Commission for fisheries and marine investigations has arranged for the marking of a considerable number of cod at the Faroes, Iceland and Greenland. The results of some of these experiments have already been described in detail in publications by Johs. Schmidt (1907), Bjarni Sæmundsson (1913) and A. Strubberg (1916); with regard to those of later years we hope to be able in due time to present similar detailed reports.

Meanwhile it may presumably be of interest, if a brief summary is given embracing all the results available up to the present. There seems all the more reason for this, as the recoveries of marked cod in recent years have brought about results, which in no small measure must modify our views regarding the extent of the wanderings of the Icelandic cod and the amount of interchange between Iceland and Greenland. It will also be of special importance to call the attention of the authorities of the countries which take part in the fisheries in these regions, to the fact that marking experiments are being planned on a greater scale than before, so that all that is possible may be done to bring information regarding recoveries of marked cod to the "Kommissionen for Danmarks Fiskeri- og Havundersøgelser".

I shall begin with an account of the percentage recoveries of marked cod in the 3 regions and then, with the aid of the charts p. 8—9, discuss the extent of the observed wanderings as well as their direction in the cases where they have been considerable. First of all it should be mentioned, that we have always marked our cod in the gill-cover and for this purpose have used buttons connected by silver wire. In the earlier experiments we used bone buttons and metal plate with number stamped on it, in the later ebonite buttons alone, which have proved better than bone buttons with metal plate. Since 1926 the buttons have been fixed by perforating one of the opercular bones with a needle, which is followed by the silver wire in a manner somewhat like a darning-needle. The "head" of the needle has a deep hole in the axis in which the wire is stuck and the greater strength of the steel needle enables an easy manner of piercing the thickest opercula in the quickest way. This method has been proposed by Captain G. Hansen of the r.s. "Dana".

It is my belief, that this method when carried out carefully by capable workers, is trustworthy. In any case we have some examples of marked fish carrying the marks for 5 years, and the reports received from other countries regarding the condition of our marked fish after recapture have also been satisfactory in the main. Naturally a certain

smartness and experience are required of those who fix the marks, and if some of the experiments seem to have failed more or less, I am inclined to believe, that one chief reason has been that too many of the fish have been returned to the sea after marking when they were hardly in fit condition to live.

It is a pleasant duty to express my thanks to Mr. Aa. STRUBBERG, cand. mag., for his valuable assistance in bringing together the available material.

II. Percentage of marked cod recovered.

In the accompanying 3 tables a synopsis is given of the marking experiments carried out at the Faroes, Iceland and Greenland from 1904 to 1929.

Faroes.

Table I. Cod-marking experiments 1909—1927.

Locality	Year	No. marked	Initial length in cms.					No. recovered	% recovered	Specimens more than 6 months out
			< 50	50-74	75-99	100-124	> 125			
Nolsø Fjord	1909 1910 1911 1912 1913 1923 1925	1,229	987	228	13	1	0	671	54.6	178
East of Nolsø	1909 1910 1911 1912 1923 1925	1,575	881	627	61	6	0	695	44.1	277
E. & S. of Suderø E. of Sandø	1909 1910 1911 1912	1.077	490	540	44	3	0	294	27.3	150
W. of Sandø W. of Strømø (incl. Vestmanhavn)	1910 1911 1912 1913 1923 1927	1.153	461	521	166	5	0	330	28.6	146
N. of Viderø	1927	239	2	96	140	1	0	35	14.6	3
Sandø Bank	1912	100	8	42	49	1	0	27	27,0	19
Faroe Bank	1910	585	2	101	425	57	0	87	14.9	7
Total...	—	5,958	2,831	2,155	898	74	0	2,139	35.9	780

1) At the **Faroes** between 1909 and 1927 altogether 5958 cod have been marked, in 6 groups at the Faroes and 1 group on the more isolated Faroe Bank lying south-west of the Islands.

As Table I shows, some of the experiments contained mainly small cod, in others there was a mixture of small and large and in a few mainly large cod.

The lowest percentage of recoveries was obtained in the experiment north of Viderø, where it amounted to 14.6, the highest in Nolsø Fjord, where it rises to no less than 54.6. On the Faroe Bank, where chiefly large spawning cod were marked, the percentage of recoveries was 14.9. The average percentage for all experiments reaches the very high value of 35.9.

The majority of the marked fish were retaken by the Faroese, with hand lines and long lines, then come British trawlers. An exception, however, is the Faroe Bank experiment, where British trawlers brought in the largest number.

2) At **Iceland** between 1904 and 1929 altogether 2989 cod have been marked. The experiments can be grouped in 5 divisions: 1 at the Westmanna Islands (western-

Iceland.

Table II. Cod-marking experiments 1905—1929.

Locality	Year	No. marked	Initial length in cms.					No. recovered	% recovered	Specimens more than 6 months out
			< 50	50-74	75-99	100-124	> 125			
Faxe Bay	1908 1925 1929	203	107	95	1	0	0	30	14.8	9
Westmanna Isl.	1925 1929	751	3	89	493	166	0	18	2.4	12
Isafjord	1928	40	0	26	12	2	0	5	12.5	2
North Coast	1905 1908 1924 1928	1,099	332	434	310	23	0	120	10.9	36
East Coast	1904 1924 1928	896	175	669	48	4	0	113	12.6	46
Total...	—	2,989	617	1,313	864	195	0	286	9.6	105

most part of the south coast), 1 in Faxe Bay, 1 on the north-west coast, 1 on the north coast and 1 on the east coast. The dimensions of the fish marked appear from Table II.

The percentage of recoveries varies from 2.4 to 14.8, but apart from the Westmanna experiment it is very uniform, varying only from 10.9 to 14.8. The average percentage for all the experiments was 9.6.

In contrast to the other experiments, the experiments at the Westmanna Islands (1925 and 1929), which lie within the main spawning region of the cod (see Chart I, p. 8) on

the western part of the south coast, were made on spawning fish, which as is known from experience spread out after spawning over large, perhaps unfished distances, whilst the younger year-groups are more stationary. This is possibly one of the reasons for the much lower percentage of recoveries.

Most of the recoveries came from Icelandic and British fishermen.

3) At **West Greenland** between 1924 and 1930 altogether 3325 cod have been marked. Excluding those marked in 1930, which are of too recent a date to be discussed, the number was 1971. From south to north the experiments may be divided into 8 groups, from Julianehaab District on the southernmost part of the west coast up to Lille Hellefiske Bank in the north.

As Table III shows, cod of all sizes from about $^1/_2$ to over 1 metre in length were marked.

Greenland.

Table III. Cod-marking experiments 1924—1929.

Locality	Year	No. marked	Initial length in cms.					No. recovered	% recovered	Specimens more than 6 months out
			< 50	50-74	75-99	100-124	> 125			
West Greenland:										
Julianehaab	1928 1929	501	4	393	87	17	0	12	2.4	6
Frederikshaab	1926 1927	194	1	179	11	3	0	4	2.1	4
Godthaab	1924 1926 1927	281	0	149	70	59	3	11	3.9	9
Sukkertoppen	1924 1925	401	4	215	178	3	1	12	3.0	12
Holstensborg	1926 1927	106	0	39	51	16	0	7	6.6	1
Fylla Bank	1924 1925 1926	271	0	40	129	101	1	26	9.6	13
Dana Bank	1925	60	0	6	45	9	0	1	1.7	0
Lille Hellefiske Bank	1925 1928	157	0	15	96	46	0	6	3.8	1
Total...	1924-29	1,971	9	1,036	667	254	5	79	4.0	46
East Greenland:										
Angmagssalik	1926 1927 1928	113	0	102	11	0	0	0	0.0	0

The percentage of recoveries is on the whole small, varying from 1.7 (Dana Bank) to 9.6 (Fylla Bank), and the average for all experiments up to 1929 inclusive is 4 %.

Most of the marks recovered came from native Greenlandic fishermen, but some

have also come from Faroese, Norwegian and French, but none so far from British fishermen. 7 specimens were taken at Iceland by Icelandic fishermen.

At Angmagssalik in East Greenland in the years 1926, 1927, 1928 and 1930 altogether 295 cod have been marked. I shall not dwell upon these experiments, which in any case have so far yielded no result.[1])

The experiments at the Faroes, Iceland and Greenland have thus given respectively 35.9, 9.6 and 4.0 as the percentages of cod recaptured.

For well-known reasons these numbers are on the small side, both because all the marks recovered have not been sent in and because the marking experiments have not all been carried out equally in technical regards. The intensity of the fishing is thus greater in all three regions than the numbers show, but there seems scarcely any doubt, that the percentages we have obtained give some notion of the extent to which the cod stock in the three regions is taxed by the fishery. In any case they indicate how desirable it is to continue the experiments in the future, as far as possible in still greater extent than hitherto.

III. Remarks on the movements of the marked cod.

With the aid of the two charts I shall now give some information regarding the extent of the wanderings of the marked cod. On the charts are noted the presumed route taken under the circumstances by the recovered cod. Only those cod are noted which may with certainty be considered to have wandered a greater distance than 150 miles.

1) The **Faroes.** The marking experiments in the Faroe region seem to indicate, that the Faroe cod do not wander very far. Of about 6000 cod marked in the region only 2 have possibly left there. The one was marked in 1913 at Sandø and was stated to have been recaptured 2 months later at 59°20′ N., 3°30′ W., thus north of Scotland. The other was marked in 1927 north of Viderø and was reported to have been retaken 2 months later in the eastern part of the northern North Sea at 59°10′ N., 3°45′ E. As the available information from the places where the recoveries were reported seemed to indicate, that one could not rely with certainty upon the positions noted, I have regarded them as doubtful for the time being and thus excluded them from the charts. In any case, however, they amount to but a fraction of the large number of cod marked in the region, namely only about 0.03 %.

2) **Iceland.** Here, as the charts show, the conditions are essentially different from those at the Faroes, as one might also expect from the other investigations on the biology of the cod here (Johs. Schmidt 1904 and 1909). The cod spawn mainly in the warmer water on the south and west coasts, and from there the pelagic fry are carried with the anticyclonic Irminger Current towards the N.W., N. and then E. coasts, where then a large proportion of the cod of Iceland grow up. The main spawning region is the western part of the south coast, and it is just here that the great spring fishery,

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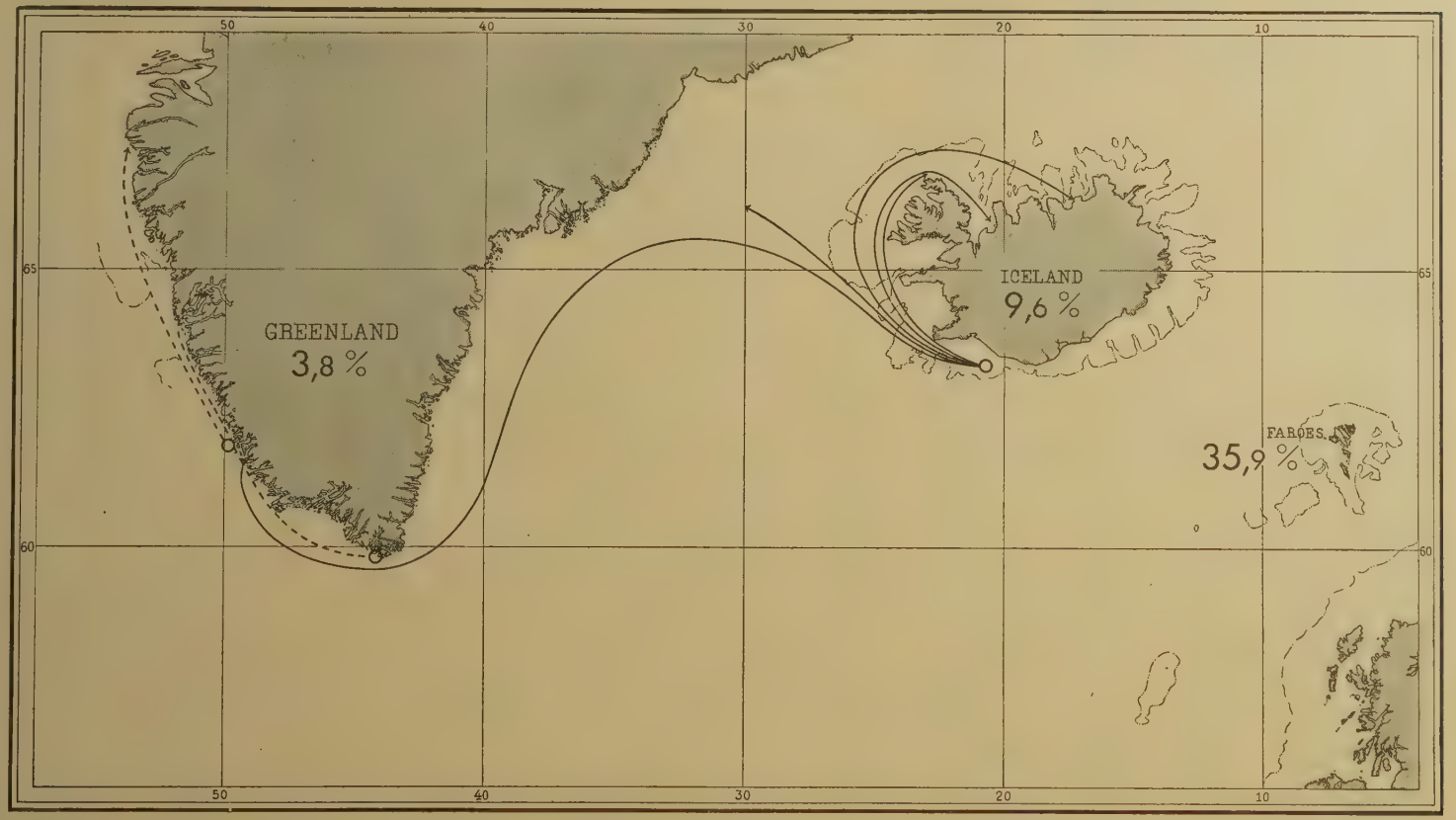
[1]) Since this paper went to press one specimen (No. 1931) marked in 1927 at Angmagssalik has been recovered at Iceland off Reykjanes in the spring of 1931.

Chart I. Marking Experiments with Cod 1904—1929.

Migrations of more than 150 miles alone were considered. The figures given indicate the percentages of the fish recovered from marking experiments at the Faroes, Iceland and Greenland[1]). The places of liberation are shown thus: o, and the places of recovery thus: →



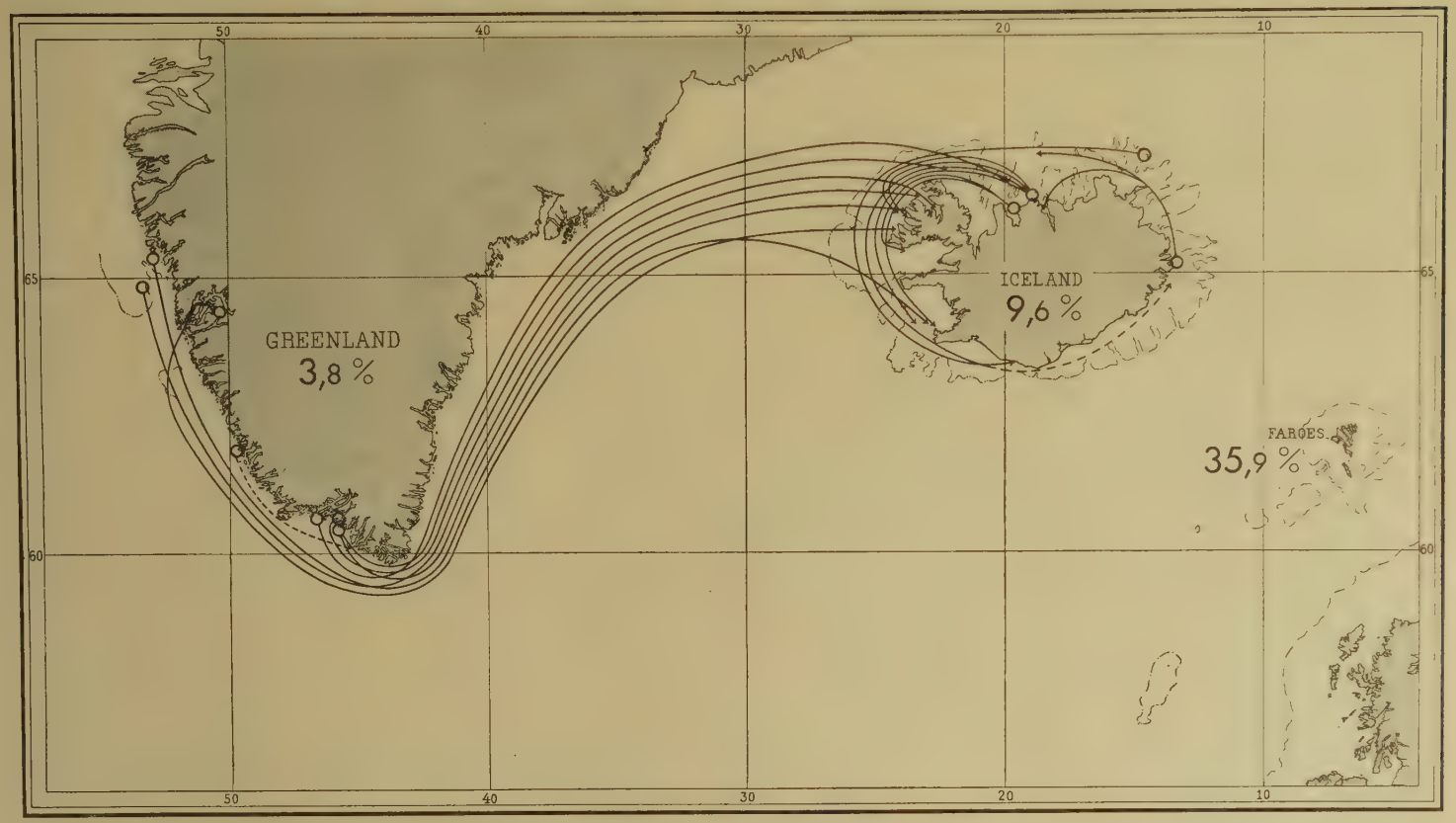
Marking Experiment April 1929 at the main spawning place at Iceland (Westmanna Isl.) showing the migrations of the spent Cod from the spawning place going in the same direction as the Irminger current (see text, p. 10).

The dotted lines along the coast of Greenland show the northwards migrations of two cod (see text, p. 10).

[1]) For Greenland the percentage 3.8 includes the experiments of 1930, exclusive of which the percentage becomes 4.

Chart II. Marking Experiments with Cod 1904—1929.

Migrations of more than 150 miles alone were considered. The figures given indicate the percentages of the fish recovered from marking experiments at the Faroes, Iceland and Greenland[1]). The places of liberation are shown thus: o. and the places of recovery thus: →



Marking experiments showing migrations of Cod against the Irminger Current towards the spawning places at Iceland (see text, p. 10).

The dotted line along the southwest coast of Greenland shows the southwards migration of a single cod. The dotted line to the south of Iceland indicates the probable route taken by a cod marked at North Iceland and recovered at East Iceland.

[1]) For Greenland the percentage 3.8 includes the experiments of 1930, exclusive of which the percentage becomes 4.

in which the fishermen of several nations participate, takes place, the spawning cod being the chief object of pursuit.

The marking experiment of most interest is the one made in 1929 at the Westmanna Islands, which lie just within the principal region mentioned for the spawning of the cod, at the western part of the south coast. The experiment was carried out in the spring in the spawning time with spawning fish. On Chart I only those cod have been included which can with certainty be said to have travelled more than 150 miles.

We see from the chart, that three cod were recovered on the west and north coasts, which they have evidently reached by moving in the same direction as the anticyclonic Irminger Current. Regarding several others it would appear, that they were recaptured a year later in the neighbourhood of the place where they were set free, but it is not excluded, that in the meantime they have made extensive wanderings and returned again to the spawning place.

Two of the cod, as can be seen from the chart, have left the Icelandic region and moved towards Greenland. One was found in the stomach of a Greenland Shark at 66° N. and 30° W., thus in the middle of the Denmark Straits, and the other was caught in southern West Greenland at Frederikshaab after having been 15 months in the sea.

These two recoveries are of special interest, providing the first evidence that the cod leaves the Icelandic region.

It has thus proved, that when the Icelandic cod scatter after the concentration connected with the spawning business on the south and west coasts, their movements, which may be called food wanderings, are not restricted, as was formerly believed, to the coasts of Iceland itself, but may extend right to West Greenland.

The second chart (II) refers to the recoveries of cod which were not in spawn when marked and which were set free on the east and north coasts as well as the west. From these experiments the probable direction of movement is shown for the 8 cod which had travelled the farthest, more than 150 miles.

It will be noticed, that the movement of these cod has been directed in the main towards the spawning places and also against the anticyclonic current round Iceland, in contrast to the movement of the spent fish (cf. Chart I), which seem specially to have followed this current movement: Irminger Current and its branch which bends over towards Greenland.

3) **Greenland.** The great majority of the cod marked and recovered at Greenland have proved to be very stationary. Chart I shows, that only two specimens have wandered over 150 miles, both in a northerly direction.

Of much greater interest is Chart II, which shows that no fewer than 7 cod marked at West Greenland have undertaken the long journey from Greenland to Iceland. I have already mentioned this in my paper on the races of cod (Johs. Schmidt, 1930, p. 8), but I wish to add here some remarks, referring to Table IV which contains the same details that were published in my paper.

In comparison with the much larger number of recoveries at Greenland itself, in all 79 specimens, the 7 retaken at Iceland form but a comparatively small total, namely about 9 % of all the recaptures. Yet two facts are of noteworthy interest.

The first is, that 6 of the 7 cod that travelled to Iceland were taken in 1930. This is indeed remarkable, when we consider that in the 6 years, from 1924 to 1929, only 1 marked cod (No. 385 in Table IV) from Greenland was retaken at Iceland. As the fishery at Iceland is constant and intensive, there seems no reason why more specimens should not have been taken in 1926, 1927 and 1928, if the immigration of cod from Greenland to Iceland proceeded regularly from year to year. The fact, evidenced by the 1929 marking experiments, that the cod may make the journey from West Greenland to Iceland in less (perhaps in much less) than 8 months, shows that these journeys can be accomplished with considerable speed.

Table IV. Cod marked at Greenland, recaught at Iceland.

No.	Initial length in cms.	Liberated	Date	Recaught	Date	Growth cm.
385	70	Sukkertoppen	27.VIII.1924	Faxe Bay.....	23.III.1927	8
870	77	L. Hellefiske Bank.....	3.X.1928	Isafjordsdyb.....	5.IV.1930	?
3116	55	Kapisigdlit, Godthaabfj.	26.VI.1926	Off Patriksfjord	8.V.1930	32
7743	82	Off Julianehaab	24.VIII.1929	Siglufjord.....	15.V.1930	2
7907	74	Unartok Fjord	3.X.1929	Isafjordsdyb.....	26.V.1930	?
7997	66	Off Sydprøven.....	5.X.1929	S. of Önundafjord.....	31.V.1930	0
8060	70	—	—	N. E. of Cape North...	10.VI.1930	?

The second outstanding fact, displayed by the 1929 marking experiments at Greenland, is that that year's experiment has given an essentially different result from the other years (1924—1928) with respect to the proportion of recaptures at Greenland itself and Iceland.

The available data show namely, that the marking experiments in the years 1924—28 yielded no fewer than 64 (**95.5** %) recoveries at Greenland against only 3 (**4.5** %) at Iceland, whereas the 1929 experiment has so far only given 8 (**66.7** %) recoveries at Greenland against 4 (**33.3** %) at Iceland.

Naturally the available data are still too few to permit of final conclusions, but it seems to me that they give grounds for the belief, that in the course of the 6—7 years we have to a certain extent kept the conditions under observation, some special cause must have been operative to account for the somewhat large proportion of the fish marked at Greenland, especially those of 1929[1]), being recaptured at Iceland in 1930. Several possibilities are conceivable, one of which I may refer to.

From the important work of Jensen and Hansen, which was published in Danish

[1]) One should however also note the circumstance, that the majority of the cod marked at Greenland in 1929 came from the southernmost part of the west coast, whereas most of the specimens marked in 1924—28 came from more northerly places. There is the possibility therefore, that the more northerly populations of cod differ from the southern in biological and migratory tendencies.

in 1930, and which with some additions and changes has been included in this Report (JENSEN and HANSEN 1931), we know, that it was the cod year-group of 1922, which has now become the main object of the fishery carried on in recent years at Greenland. A large proportion of this dominant year-group must presumably have reached maturity for the first time in the winter of 1929—30, and it is therefore possible that in this we should see the principal reason for the sudden change of picture when so many more, relatively, of the marked cod were recovered at Iceland. The spawning instinct may have led them over here, presumably because at Greenland they could not find the outer conditions necessary for spawning, which as we have seen recur year after year with the greatest constancy at the south-western parts of Iceland. This region must on the whole be regarded as the great centre of attraction in the spring for the enormous numbers of spawning cod, not only, as we thought formerly, from the Icelandic region alone, but also from Greenland. It results from this, that the great concentration of mature cod at South-west Iceland in spring — where the conditions year after year are favourable for the spawning of the cod — leads to the Icelandic spring fishery always remaining as the principal and especially the most constant cod fishery in these northern regions.

As the facts have unfolded themselves, the further clearing up of these exchanges of cod between Iceland and Greenland and the reverse, seems to me one of the principal biological tasks in our area, and we may look forward with hope to what the marking experiments may further reveal.

At the conclusion of this summary of the Danish marking experiments in our area during the last quarter of a century I wish, in the name of the Danish Commission, to convey our best thanks to all who have helped in our work.

In the first part of the period the experiments were restricted to the Faroes and Iceland, where they were carried out partly by our own staff on the two research-vessels, first the "Thor" and then the "Dana", or on hired vessels, partly by local fishermen. In more recent years the Icelandic authorities have given us very important help by carrying out the marking from Icelandic inspection vessels, and for this assistance I would express our best thanks here.

As regards Greenland, the marking experiments were begun in 1924 on my initiative, being carried out on board H.M.S. "Islands Falk" and by other means by Dr. Å. V. TÅNING, assistant to the Danish Commission. Later, through the goodwill of the Greenland Government and of its adviser in fisheries, Prof. AD. S. JENSEN, they have been continued right to 1930. Our best thanks are due to both, and also to Mr. PAUL HANSEN who has done the marking since 1926.

I would finally thank the master of our research-vessels "Thor" and "Dana", Captain G. HANSEN, who has introduced various improvements in the technique of marking, and who is himself an incomparable master in such matters.

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IV

ON THE OCCURRENCE OF THE COD (*GADUS CALLARIAS* L.) AT EAST GREENLAND

BY

JOHS. SCHMIDT

I.

That the cod occurs at West Greenland, has long been a well-known fact. It is different as regards East Greenland, from which hitherto we have had no definitely determined specimens of this species (cf. Ad. S. Jensen's work on the Fishes of East Greenland, 1903).

It was with no little surprise therefore, that during my efforts to obtain materials from the Danish colonies in Greenland for my work on the races of the cod (Johs. Schmidt, 1930, p. 8), I obtained samples not only from West Greenland but also from the Angmagssalik colony on the east coast (65°30′ N., 37°30′ W.). Examples from here were received both in 1926—27 and 1930, and their investigation has thus given a definite answer with regard to the cod's occurrence on the east coast of Greenland.

It is of interest to enquire what other records are available of the cod's occurrence at the Angmagssalik colony. My information comes from two governors of the colony, Johan Petersen (in Angmagssalik 1884—85, 1894—1915 and 1923—24) and A. Hedegaard (Angmagssalik 1914—23, 1924—1930).

In a letter of 9.XII.30 Johan Petersen informs me that, so far as he can remember, the sea-cod was first noticed at Angmagssalik in 1912; previously it had not been known to the eskimos of that place. Since 1923 it has become fairly common and in recent years has occurred in large quantities everywhere in the district.

From A. Hedegaard again I have received the information by word of mouth (6.IX.30), that it was about 1920 that the cod began to appear, only a few thin and wasted specimens having been taken earlier. From 1917 onwards Mr. Hedegaard has himself fished in the Angmagssalik fjord, almost at its head. His hooks took sea-scorpions, Sebastes, Greenland halibut etc., but no cod. In 1920 he handed over his apparatus to a Greenlander who continued the fishery, but it was not until the autumn of 1926 that cod were obtained. Mr. Hedegaard states further, that the cod is now found throughout the year, the large quantities of large cod mainly from May to July. Numbers of small cod also occur, even those down to 5—6 cm. in length (observed in July 1930).

In a letter from Angmagssalik dated 29.VI.30 Mr. Hedegaard reports that the marking of cod, undertaken at my instigation, was carried out at the head of the fjord (Tasiussak). "Cod have been present there in large shoals from the end of May, ... also at other places in the district: Cape Dan, Amitsuarssik etc."

To these notices I may add that Captain Holm, founder of the Angmagssalik colony, reports (1918, p. 297), with governor Johan Petersen as source of information, that "true sea-cod also occur from time to time".

From the foregoing therefore it seems possible to conclude, that in the occurrence of cod at Angmagssalik we are faced with a new phenomenon, unknown to the Danish governors before 1912 and, according to their statements, also unknown to the Eskimo natives. It is not without interest in this connection, that JOHAN PETERSEN and A. HEDE-

Chart showing the position of the Angmagssalik district (arrow pointing at the district). Average, minimum and maximum of distribution of ice shown. (From G. HOLM 1918).

GAARD both affirm that the Angmagssalik Eskimo have no special name for the cod. They make use of the West Greenland name "sarugdlik"; on the other hand, they have special East Greenland names for the other fishes commonly occurring at the place.

In the last 5 years the cod has thus occurred in quantities in the Angmagssalik

district, and it has been met with in smaller quantities since about 1912. This is the outstanding fact, but we can scarcely doubt also, that the phenomenon is of recent date in these parts of Greenland, at any rate as far as large quantities are concerned. Such an occurrence would hardly have passed unnoticed by the native population who knew so well and utilized other, less valuable species of fish.

The question now arises quite naturally, whether the earlier northerners who visited East Greenland had noticed and reported on the presence of cod in these waters. To answer this I have sought the counsel of Captain G. Holm, who in his Expedition of 1884—85 discovered the Eskimo race living at Angmagssalik and arranged for the establishment of a Danish colony there. Captain Holm informs me in a letter of 13.XII.30, that he knows no other reference to the cod here in the earlier literature of the old Icelanders than what is given in Björn Johnsen's Greenland Annals ("Grønlandske Annaler"). This was cited by G. Holm (1928, p. 297) and refers to a voyage made on board an English vessel by an Icelander named Clemens from Látrum in Aðalvík in Iceland to the Gunbjørn Islands near Angmagssalik, presumably between 1586 and 1596. It is narrated, that one of the boats of the vessel rowed into the bay. "The crew intended to go on land to shoot birds but noticed that the bay was full of cod. They made the boat fast and loaded it full with cod, just as a sample of what the bay held".

As this is reported by an Icelander who in his homeland was extremely well acquainted with the cod, there seems no doubt, that the fish discovered filling the bay at Angmagssalik about 1590 was really the cod (*G. callarias*). It would therefore seem not unreasonable to conclude, that the great abundance of the cod at Angmagssalik at the present time, is in reality nothing new but a periodically recurring phenomenon[1]).

II.

The samples sent me from East Greenland for the racial investigations, in 1926, 1927 and 1930, and the marking experiments carried out at the same place, show that all sizes of cod, from the I-group to specimens of 110 cm. in length occur at Angmagssalik. This can be seen from the measurements given in Tables I—III, p. 6—7.

The material for the racial investigations was also utilized to determine the ages, by Mag. sc. Arni Friðriksson, and the results are given in the Tables I—II, p. 6—7. As the smaller fish were preferably sent me, these samples are naturally not representative — the measurements from the marking experiments p. 7 show this — but the age determinations show with clearness, that in 1927 the III-group, in 1930 the II-group was dominant. The group which came into the world in 1928 amounted in 1930 to not less than 88 per cent. of the whole sample.

Where the Angmagssalik cod has its spawning place, has not yet been determined. It is not altogether excluded that the cod, at any rate in some years, spawns off the Greenland coast, but there is also the possibility that pelagic cod fry are transported from the Icelandic banks.

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[1]) I may not quite exclude the possibility, however, that the species may have been the gadoid *Gadus saïda*, a small fish occurring in East Greenland and in the fjords here.

Table I. Cod from East-Greenland 1927.

Age-group Year-class	II 1925	III 1924	IV 1923	V 1922	VI 1921	VII 1920	VIII 1919	Total
cms.								
45	..	..	..	1	..	..	..	1
44	..	..	..	1	..	..	..	1
43	..	..	..	..	..	..	..	..
42	..	1	..	..	..	..	..	1
41	..	..	..	..	..	..	..	..
40	..	..	..	..	1	1	..	2
39	..	..	..	..	..	..	1	1
38	..	..	..	..	..	..	..	..
37	..	..	..	..	1	..	..	1
36	..	..	1	..	1	..	1	3
35	..	2	1	2	..	..	..	5
34	..	1	..	..	..	..	..	1
33	1	2	3	1	..	1	..	8
32	..	2	1	3	1	..	..	7
31	..	6	4	1	..	..	..	11
30	..	11	6	3	1	..	..	21
29	..	6	5	1	1	..	..	14
28	..	13	4	1	..	1	..	19
27	..	8	2	2	..	..	..	12
26	..	14	1	..	..	..	..	15
25	..	7	3	..	..	..	..	10
24	1	9	..	..	..	..	..	10
23	..	5	..	..	..	..	..	5
22	..	9	..	..	..	..	..	9
21	..	2	..	..	..	..	..	2
20	..	1	..	..	..	..	..	1
19	..	1	..	..	..	..	..	1
18	1	1	..	..	..	..	..	2
Total	3	101	31	16	6	3	2	162
Percentage	1.9	62.3	19.1	9.9	3.7	1.9	1.2	100

I have shown earlier (Johs. Schmidt 1904 and 1909) that the north and east coasts of Iceland are for the most part provided with cod fry which come into the world at the important spawning places on the south and west coasts, being carried from there round Iceland with the anticyclonic Irminger Current. Regarding this I may refer to to the results of our latest drift-bottle experiments, described in the present report by Dr. Å. V. Tåning (Tåning 1931).

This report shows, that whilst the majority of the bottles thrown out on the south and west coasts of Iceland have moved clockwise round the north and east coasts, yet a single bottle has been carried over to Greenland, and one may conclude that more would have gone that way had they been thrown out somewhat farther west off the Icelandic coast. It is not improbable, therefore, that some of the drifting cod fry may

Table II. Cod from East-Greenland 1930.

Age-group / Year-class	I 1929	II 1928	III 1927	IV 1926	Total
cms.					
27	..	..	2	1	3
26	..	..	..	..	..
25	..	..	1	..	1
24	..	4	2	1	7
23	..	4	4	1	9
22	..	4	3	..	7
21	..	22	..	..	22
20	..	18	..	..	18
19	..	31	..	..	31
18	..	23	1	..	24
17	..	17	..	..	17
16	..	6	..	..	6
15	..	3	..	..	3
14	1	..	..	..	1
13	..	1	..	..	1
12	..	..	..	..	..
11	1	..	..	..	1
Total	2	133	13	3	151
Percentage	1.3	88.1	8.6	2.0	100

Table III. Length of Cod marked in East-Greenland (Angmagssalik) 1927 and 1930.

Length in cms.	1927	1930	Length in cms.	1927	1930	Length in cms.	1927	1930
110	..	1	76	3		59	1	6
:	..	..	75	2	4	58	2	10
103	..	2	74	..	..	57	..	12
:	..	..	73	..	2	56	1	9
95	1	..	72	4	2	55	3	8
94	1	..	71	3	3	54	..	6
:	..	..	70	3	4	53	2	6
86	1	2	69	10	7	52	1	7
85	..	3	68	6	2	51	..	2
84	..	2	67	9	4	50	2	3
83	..	3	66	6	2	49	..	4
82	..	3	65	5	7	48	..	3
81	..	2	64	13	4	47	..	..
80	..	3	63	6	9	46	..	1
79	..	2	62	8	11	45	..	1
78	..	2	61	2	7			
77	..	2	60	5	6	Total ...	100	181

be carried with the part of the Irminger Current deflected N.W. across to Angmagssalik, come under the coast there and grow up to mature fish. That all size-groups of cod from the I-group to fish over a metre in length, occur at Angmagssalik is now a known fact, which shows that the cod grows up on this part of the East Greenland coast.

The result of my race investigations (Johs. Schmidt 1930, p. 10 and the tables pp. 50—52) shows that the Angmagssalik cod have almost the same numerical values as the highest found at Iceland, so that the results from this side of the investigations seem in no way opposed to the view, that the Angmagssalik cod may be of Icelandic origin.

With regard lastly to the marking experiments undertaken at the instance of the "Kommissionen for Danmarks Fiskeri- og Havundersøgelser" at Iceland, the results obtained during the past year are of special interest in this connection, especially an experiment carried out in April 1929 when 500 spawning cod were marked and set free at the Westmanna Islands. Whilst the majority of the recovered specimens came from the west and north coast of Iceland, exceptions were found in the case of 2 specimens which had travelled over to Greenland. One of these (No. 1465, length 100 cm.) was recaptured in the middle of the Denmark Straits between Iceland and Greenland (65° N. 30° W.), the other (No. 1310, length 107 cm.) in the southern part of Greenland, in the Frederikshaab district.

The marking experiments undertaken in Greenland (Johs. Schmidt, 1930, p. 9—10) also show, that there is a greater connection between the cod of Greenland and Iceland than was previously known, as of the cod marked at West and South Greenland 7 specimens (6 in the spring and early summer of 1930) have been retaken on the west and north coast of Iceland.

When we consider that the journey from Iceland to Angmagssalik is far shorter than that to the west coast of Greenland, it does not seem unreasonable to believe, that there is a close connection between the cod of Iceland and this part of East Greenland. It remains for the investigations of the coming years to throw further light on this interesting question.

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V

DRIFT-BOTTLE EXPERIMENTS IN ICELANDIC WATERS

BY

Å. VEDEL TÅNING

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I. Introduction.

In the years 1928 and 1929, on the instigation of Professor JOHS. SCHMIDT, Dr. phil., some experiments with ordinary surface drift-bottles were made in the waters round Iceland on behalf of "Kommissionen for Danmarks Fiskeri- og Havundersøgelser". These were intended to throw light on the currents, which as known are of decisive importance in the distribution of fish eggs and fry along the Icelandic coasts. Both the direction and speed of the currents are of significance in this distribution and, so far as the surface current is concerned, the experiments carried out give valuable information on these points besides increasing our knowledge beyond the experience obtained by earlier experiments.

Just as in earlier experiments with drift-bottles we may assume that some later recoveries will still come in, but as the main reasons for carrying out the experiments were simply to obtain information regarding the direction and speed of the current at Iceland, with reference to the biological problems in that region, returns of drift-bottles coming much later, perhaps years after the beginning of the experiment, will be of little interest, even though in certain cases they may be of importance from the hydrographical standpoint. From Iceland itself no drift-bottles have been reported later than 4—5 months after the experiment was started.

For the success of the experiments our thanks are due to the captains of the vessels from which the bottles were thrown overboard and also to the many who sent in information regarding the bottles found.

II. Earlier Experiments with Drift-bottles in Icelandic Waters.

In earlier years quite a number of experiments with surface drift-bottles have been made in the waters round Iceland and as we shall refer to these in the following account we may note here the following publications on the subject.

1) C. F. WANDEL: Rejseberetning. Den danske Ingolf-Expedition. Bd. I, 1. Page 18—19. 1898. *Ibid.* Strømflasker. Bd. I, 4.

2a-b) C. RYDER: Nogle Undersøgelser over Havstrømmene etc. Det danske Met. Inst. nautisk-meteorologiske Aarbog. 1901, page I (2a). *Ibid.* 1904, page I (2b).

3) ANON.: Flaskedrift. *Ibid.* 1924, page LIX. København 1925.

4) J. N. NIELSEN: Contribution to the understanding of the currents in the northern part of the Atlantic Ocean. Meddelelser fra Komm. for Havundersøgelser. Hydrografi. Bd. I. No. 11. 1908.

J. N. Nielsen's experiments were carried out in 1905 in the open sea west and north-west of the Faroes and up towards Iceland. They revealed a very distinct drift from this region towards the Faroes, Shetland Islands and the Norwegian coast from 61° N. L. approximately to the Murman Coast. Only 3 bottles were stranded on South Iceland and these presumably were caught in the westgoing movement along this coast,

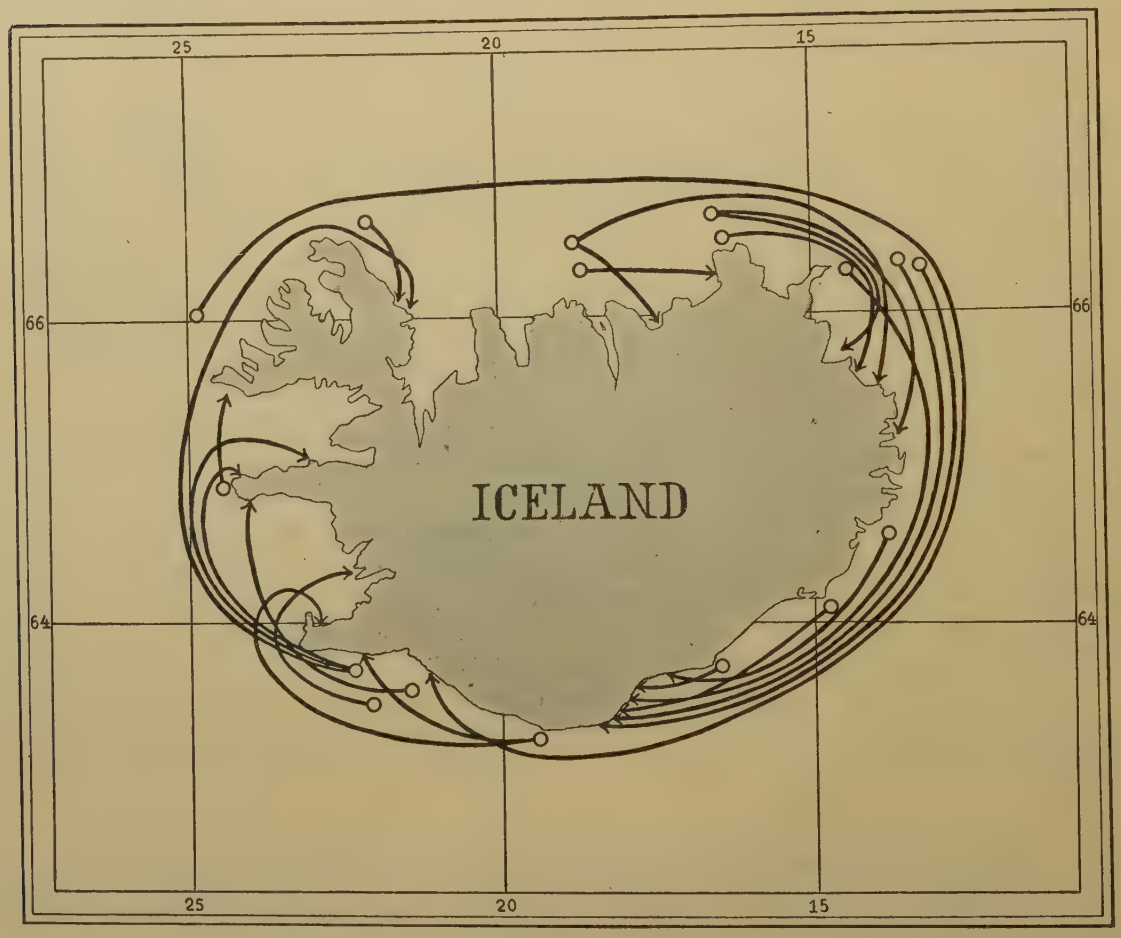

Fig. 1. Drift-bottle Experiments 1908 (by Prof. Johs. Schmidt).

whereas the majority of the bottles have left the Icelandic region, with the East Icelandic polar current and with the Atlantic current moving towards the east and north-east across the Norwegian Sea. Nielsen criticizes several of the earlier experiments in this region (Ryder) and puts forwards a more reasonable explanation of certain features of the currents here than had been advanced previously.

In 1908 several series of drift-bottles were thrown out by Prof. Johs. Schmidt from r.s. "Thor" along all the coasts of Iceland, in similar manner to the later experiments. As the results of these experiments have not hitherto been published, and as

they are of no small interest along with the recent, we give a summary of them here along with a chart based on the experiments. — As the chart (Fig. 1) shows, between 1st June and 3rd August 1908 but chiefly in the month of July about 280 drift-bottles altogether were thrown overboard on all the coasts of the island. The bottles recovered came from the Icelandic region (22 bottles) and they had moved round the land in the direction of the anticyclonic current. According to the chart none had left the land, neither from the south-west coast, where about 100 bottles had been put in the water, nor those from the east coast numbering about 35 bottles. The experiment showed therefore, that from about July and in the following months of 1908 the currents round the coasts of Iceland were of a typical anticyclonic character.

With regard to the hydrography of the Icelandic waters however, we may refer to the series of papers published by Prof. M. KNUDSEN and Dr. J. N. NIELSEN in the "Meddelelser fra Kommissionen for Havundersøgelser", Hydr. Bd. I; also to Report of North-western Area Committee 1924—25, Rapp. et Procès-Verbaux XXXIX, p. 73 (J. P. JACOBSEN and AAGE J. C. JENSEN) and to Annalen der Hydrographie und mar. Meteorologie, LVIII, 1930, p. 233 (G. BÖHNECKE, E. HENTSCHEL und H. WATTENBERG: Über die hydrographischen, chemischen und biologischen Verhältnisse an der Meeresoberfläche zwischen Island und Grönland. "Meteor", August 1929).

III. Experiments in 1928—29.

A. Arrangement of the Experiments.

The bottles used were ordinary champagne bottles, in each of which was placed a numbered card with questions on the one side, as usual, for the finder to answer. The bottles were weighted with sand so that they would float in water of about 34—35 ‰ salinity and in such a manner that they remained vertical with a few cms. of the neck above the surface of the water. They were corked tightly and the mouth dipped in pitch. To regulate the order of dispatch they were also numbered on the outside. On the card, which bore the following address: Mission océanographique, Carlsberg Laboratorium, Copenhague, Danemark, the following questions were written on the back in English and Danish: "The finder is kindly requested to fill in this postcard and return it by the post. On receipt of the postcard a reward of 1 shilling will be sent to the finder. — The locality where found? — When found? — Name and address of finder: —".

The experiments embraced altogether 580 drift-bottles, which were put into the water from the following vessels.

1928. Bottles 1—150 were thrown out from the s.s. "Island" (Captain L. D. LYDERSEN), 151—200 and 251—300 from the s.s. "Dronning Alexandrine" (Captain P. V. FRANDSEN) and 201—250 from H.M.S. "Fylla" (Captain P. IPSEN of the Danish Navy). Of these 300 bottles 20 had to be rejected as they were more or less damaged during transport. The bottles were thrown overboard at a distance of about 3—15 miles from the coast.

1929. All bottles (301—600) were thrown out from H.M.S. "Fylla" (Captain

C. F. v. der Hude of the Danish Navy) and none had to be rejected. They were thrown overboard at a distance of about 5—14 miles from the coast.

The localities of the separate experiments will be seen from the lists pp. 17—20 and from the chart (Fig. 2, p. 8). In this paper all the drift-bottles reported up to 1st February 1931 are included. The measurement of the presumed distances covered has been made on various sea-charts (size 1 : 550,000—1 : 3,700,000).

It may be emphasized here, that these experiments with simple, weighted surface-bottles cannot yield the more accurate information given by drag-fitted drift-bottles (see J. N. Carruthers' paper in the Journal Marine Biol. Ass. Vol. XVII, 1930, pp.241—275); yet it may be maintained, that the uniformity of the results obtained on the whole by the experiments, shows that well-balanced surface bottles can yield results of some value to the study of marine biology. Nevertheless it must not be forgotten in any way that the sources of error in fixing the routes of the drift-bottles are many and cannot be eliminated.

B. The separate Experiments.

1. Experiments of 1928.

Experiments No. I (see charts figs. 2 & 3).

Of the 25 drift-bottles thrown out information regarding 7 (28 per cent.) recovered has been received up to the present.

Of these 7, two were stranded on Reykjanes, 1 on the south side of and 1 west of Faxe Bay; 3 have left Icelandic waters and by way of the West Iceland-Greenland current and the North Atlantic current have reached Ireland, Scotland and Norway. The Rockall Bank probably forms the place of separation of the bottles going towards the north-east from those going more to the south-east (Ireland); this seems confirmed by the experiments made here by Prof. Schmidt in 1908 (Rapp. et Procès-Verbaux. X. 1910, pp. 226—227).

The presumed average speed of drift lies about 2—$3^1/_2$ miles per diem, being lowest for the bottles with a long drift; for No. 20 only is it considerably higher, 7 miles. The last example is of special interest, as the bottle was fished up at sea and thus may be supposed to have covered the distance without, like the others, lying for some days on or near the beach before being discovered. Further, the rate does not exceed the known speed of the current in these parts of Iceland.

No drift-bottles from this experiment were found farther north on the west coast of Iceland, and there is none to show that any have penetrated into the East Greenland current; presumably the few bottles carried far away have left the Icelandic coastal current right at the southern parts of the west coast (as No. 20 also seems to indicate).

Experiment No. II (se charts figs. 2 & 3).

Of the 25 bottles thrown out the recovery of 6 (24 per cent.) has been reported.

Of these 2 were retaken near the place where they were thrown into the sea, 2 landed on Reykjanes and 1 on the south side of Faxe Bay; only 1 has been reported

from other parts of the North Atlantic, namely from Scotland, and this has probably followed a similar route to the above mentioned. The speed has apparently been about 2.3 miles per diem. None has been found to the north along the west coast of Iceland, nor have any of these apparently been carried into the East Greenland current, where, however, most bottles of this type would probably be crushed in the ice.

Experiment No. III (see chart fig. 2).

Of the 25 bottles in this lot 4 (16 per cent.) have so far been reported as found again.

All 4 were recovered a short time after they were thrown out, at Snæfellsnes; none occurred farther north or elsewhere; where the majority went to, is thus unknown. The currents are strong at this point and the drift of the bottles also shows high values, up to 7.5 miles per diem.

Experiment No. IV (see chart fig. 2).

Of the 24 bottles thrown out not a single one has been recovered. This experiment along with the foregoing leads one to suppose, that these drift-bottles have not kept in the coastal current, but have ended their drift in the ice masses of the East Greenland current.

Experiment No. V (see chart fig. 2).

Of the 25 bottles in this experiment the recovery of only 1 (4 per cent.) has so far been reported; this was found quite close to the place of liberation, in Havnvík. Like the foregoing this experiment was made in the month of April and the results are quite the same as in the other cases; the following experiment, however, carried out almost at the same place about June 1st, shows a higher recovery of drift-bottles.

Experiment No. VI (see chart fig. 2).

Of 47 bottles thrown out information regarding 6 (12.7 per cent.) has been obtained up to the present. All these bottles have obviously been carried with the ingoing current into Hunaflói, as the recoveries were found on the shore of this bay on the west side, from Barðsvík to Broddanes. The speed of the drift has not been great; otherwise the bottles must have lain for some time near the coast or on the beach; the greatest speed is 4 miles per diem.

These bottles were set free about one month later than those of Experiment No. V and about 5 miles south-east of the latter's position; whether it has been the slight difference in position or the greater in time, or both together, which has affected the result, this is certainly somewhat different in the two cases.

Experiment No. VII (see chart fig. 2).

23 bottles thrown out and up to the present 4 (17.4 per cent.) reported as recovered.

Of these bottles 2 have followed the prevailing current towards the east and stranded

in the two large bays Skjálfandiflói and Axarfjord. The other 2 were carried into Hunaflói, thus against the prevailing current; here we may presume, that either the wind from the east or north-east or the ebb has been so strong for a shorter or longer period after the bottles were thrown out, that these were carried over to the west side of Hunaflói and then followed the prevailing current until they stranded. It may be remarked that the weather conditions on the north coast during three days just after the

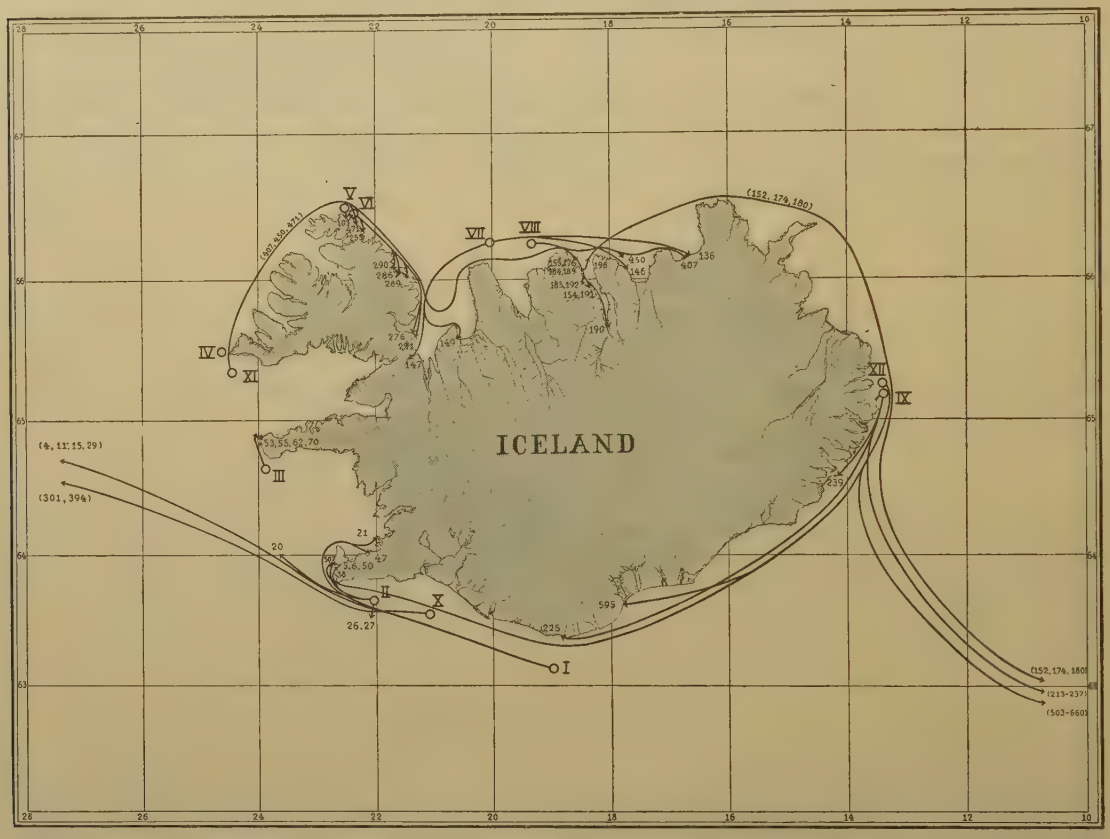

Fig. 2. Drift-bottle Experiments 1928—29. Icelandic area.

bottles were cast into the water were fairly quiet; throughout the following week, however, the wind was a fresh gale from the north-east [1]). In Hunaflói, it is said, the ebb is not noticeable farther in along the west coast than to Drangarnir (see "Den islandske Lods", København 1927, p. 34). For these reasons the bottle no. 147 must be considered probably to have crossed the bay pretty far out and then to have followed the ingoing current to the place of stranding. There is a possibility that the bottle no. 149 may have taken a shorter route (perhaps even shorter than indicated on the chart), since it came to land at the most 21 days after being put in the sea, whereas no. 147

[1]) I am indebted to Dr. J. N. Nielsen for this information.

was not found till after 57 days. Apart from the bottle no. 149 the speed of the drift is slow, indicating that the bottles have drifted around, perhaps forwards and backwards, for some time before they came into the prevailing current. How far something similar may also occur to the fish fry in this region, cannot be judged owing to the lack of observations. A stoppage or to and fro drift in this locality will naturally have a great influence

Fig. 3. Drift-bottle Experiments 1928—29. The long-drifting bottles.

on how far in certain years the fish fry penetrate to the east, a question of no little interest for the biological studies in these waters.

None of the drift-bottles in this experiment has left Icelandic waters.

Experiment No. VIII (see charts figs. 2 & 3).

45 drift-bottles put out; recoveries so far reported number 13 (28.9 per cent.).

Of these 10 have followed the strong east-going coastal current and have penetrated into Eyjafjord, one indeed getting right in to the innermost part of this ca. 34 miles long fjord; almost all the bottles have stranded on the west side of the fjord. 3

of the bottles have drifted to Norway, and no. 196 was obviously going the same way but was observed already in the eastern part of the mouth of Eyjafjord. The bottles which went to Norway (Helgeland and West Finmark) have apparently left Iceland on the east coast and then drifted north of the Faroes and so to Norway.

The drift speed for the bottles stranded in Eyjafjord is very variable, but some bottles probably remained some time before they were found. On the route indicated on the chart for the bottles stranded in Norway the speed seems to have been ca. 3.2—4.4 miles per diem; a drift somewhat more to the north of the Faroes would give a somewhat greater speed; naturally, it cannot be said which route has been followed (cf. also Dansk Met. Aarb. 1925, p. LXI).

Experiment No. IX (see charts figs. 2 & 3).

Of the 41 bottles thrown out 9 (22 per cent.) have been recovered so far.

Only 2 of these have remained in the Icelandic region. Following the anticyclonic coastal current round the island one was stranded on Papey, the other not far from Portland on the south coast; the latter has thus continued westwards along the south coast in the Atlantic current, which it has entered at some place or another on the south-east coast. Of the remainder 1, found in Kalsøfjord in the Faroes, indicates the direction of the current flowing to Norway from the East Icelandic waters where the bottles were thrown out. The bottles which have reached Norway have probably passed close to the north of the Faroes; they have all landed north of 68° N.L. in Norway. Nos. 213 and 237 were found near one another; the reason for the great difference in time of drift must be apparently, that the one was only found after lying a long time on the beach; the same applies probably to no. 234 at any rate. Nos. 223 and 230 indicate presumably the correct average speed for most of the drift-bottles of this experiment from East Iceland to Northern Norway at this time of year (5.4—5.6 miles per diem); a more northerly and thus shorter route would give a higher speed, but this does not agree with the other observations from this region. The speed on the route from Iceland to the Faroes (no. 219: 1.8 miles) is here as in other experiments lower than for the bottles that drifted to Norway; the current increases considerably in speed along the coast of the latter and this increases the average rate.

General Review of the 1928 Experiments.

In 1928 280 drift-bottles were thrown into the sea at 9 places round all the coasts of Iceland; of these 50 or 17.9 per cent. have been returned; the different experiments, however, have yielded extremely different results, the percentage of recoveries varying from 0 to 28.9.

The majority (36) of the bottles recovered came from the Icelandic region, yet 14 or 5 per cent. drifted to more distant waters: Ireland, Scotland, the Faroes and Norway. None of the bottles from the 1928 experiments was found at Greenland, but naturally this does not mean that none has drifted over there. One may suppose indeed, that a great number of the bottles in the experiments IV and V for example have

	No. of bottles	No. recovered	From outside Iceland
Experiment I	25	7	3
— II	25	6	1
— III	25	4	0
— IV	24	0	0
— V	25	1	0
— VI	47	6	0
— VII	23	4	0
— VIII	45	13	3
— IX	41	9	7
Total	280	50	14
Percentage	100	17.9	5.0

probably been lost in the East Greenland ice; otherwise it is almost inexplicable why the number of bottles recovered is so low just in those experiments. One may remark here, that not one of the bottles thrown out in these experiments was recovered from the coasts of North-West Iceland with its numerous fjords, and taken on the whole only 2 cases of bottles being stranded here occur in the previously mentioned literature. Further, drift-bottles have seldom been recovered from the Brede Bay or the northern part of Faxe Bay. The reason for this can hardly lie exclusively in the possibility, that the bottles influenced by the prevailing SW.-winds are more often broken here against the rocks than elsewhere round Iceland. Of more importance here seems the fact, that the current at Látrabjarg runs strongly away from the land and thus gives the bottles a westerly drift.

In the case of the drift-bottles which have not left the Icelandic region the direction of drift has been the well-known anticyclonic tendency round the island, as already shown previously, for example in 1908. It is only now and then that the ebb tides or prevailing winds over a long period of time can bring about a contrary movement (see Exp. VII). The drift-bottles have been found not only far inside the wider bays (e.g. Exp. I, II and VI), but also right at the head of, for example, the very long and narrow Eyjafjord on the north coast (Exp. VIII). As will be seen, these experiments agree with those of 1908, but there is one difference on an important point; none of the bottles in the 1908 experiments was recovered from other parts of the Norwegian Sea or North Atlantic, as has been the case in the experiments of both 1928 and 1929.

The drift-bottles of 1928 which have left the Icelandic region have obviously drifted on the one hand into the large current system south-west of Iceland, and thence to Ireland, Scotland and Norway, and on the other hand into the not less powerful current system south-east of Iceland (East Icelandic and Atlantic currents), through which they have been carried to the Faroes and Norway.

The drift-bottles seem to leave Iceland either at the south-west corner or on the east coast. Owing to the anticyclonic movement it is possible for drift-bottles to leave the island from localities on all coasts; but it may be noted, that the present experiments (and those also of 1929) show that the departure has taken place more especially or almost exclusively from the localities on the south-west and east coasts.

With regard to the bottles showing a prolonged drift, it need only be remarked here, that those found on the Norwegian coast were found only in the northern parts from Helgeland to the North Cape (see the separate experiments I, II, VIII and IX).

The speed of the drift lies about the same dimensions as those known from the earlier experiments of a similar kind in these waters (up to 7—9 miles per diem); in a number of cases it seems so low as to suggest the obvious explanation, that the bottles have lain for a long time unnoticed on the shore, which naturally may often happen on the sparsely populated coastal stretches, whether these are rocky or, as on the south coast of Iceland especially, desolate and sandy spaces.

2. Experiments of 1929.

Experiment No. X (see charts figs. 2 & 3).

Of the 100 drift-bottles thrown out only 2 so far have been recovered and reported (2 per cent.) and these 2 had been carried far from the Icelandic region, whilst none has been found along the coasts of Iceland. The cause of the latter phenomenon may have lain in the weather conditions prevailing on the days following the beginning of the experiment (14th February 1929 with the wind S.E.—N.E. (4—6) persisting during the following days; the bottles were put out about 2 days after spring tide so that the current has probably been running strongly to the westward).

One of the bottles recovered was found at Sydprøven in South Greenland not more than 133 days after being thrown out, whilst the other has escaped from the East Greenland current; probably by way of the current circulating in the Denmark Straits and south-west of Iceland it has come into the eastgoing Atlantic current and stranded on the coast of Ireland, like the bottle already noted in Exp. I. The speed of drift for the first bottle, as might be expected, was high, at least 6 miles per diem, for the second only half this.

In the 1908 experiments a number of bottles were thrown out in June—July almost at this place, and several were returned from the Icelandic region; the 1929 experiment took place in February and none was recovered from that region; this would indicate a more purely westward movement of the Atlantic water along the south coast of Iceland, away from the land, at this time of year.

Experiment No. XI (see chart fig. 2).

Of the 100 bottles thrown out only 3 (3 per cent.) have so far been recovered, all from the north coast of Iceland. The low recovery percentage is in agreement with the previously mentioned experiments of 1928 on this part of the Icelandic coasts. The bottles have accompanied the anticyclonic water movements northwards and eastwards along the north coast. A couple of the bottles have obviously lain for some time before discovery, which accounts for the unusually long drift period.

Experiment No. XII (see charts figs. 2 & 3).

Of the 100 bottles thrown out a somewhat large proportion has been recovered, namely 19 (19 per cent.). The experiment is of special interest in that only 2 of the bottles remained within the Icelandic region, the remainder (17) drifting to the Faroes and Norway.

The two bottles recovered from Icelandic territory have followed the anti-cyclonic current; their drift ended on the south and south-west coast. The great majority of the bottles in this experiment must be considered to have passed the Faroes, where no fewer than 6 were found. On the Norwegian coast the bottles, as usual, were found from the Trondhjem Fjord district up to Varanger Fjord. The speed of drift in the Icelandic coastal region seems to have been quite 3 miles per diem. On the way to the Faroes it has been low (1.0—2.6 miles per diem, average 1.4), and then the bottles — after coming under the influence of the Atlantic current — have increased their speed to such an extent that the average rate for the whole journey has been about 3.5 (varying but little, from 2.9—4.1 miles per diem). For the bottles which reached the Faroes and Norway we have the following supposed distances and speed, which illustrate clearly what has just been said.

Faroes			Norway		
No. of days on the way	Supposed distance (miles)	Average speed (miles per diem)	No. of days on the way	Supposed distance (miles)	Average speed (miles per diem)
97	250	2.6	191	720	3.8
208	270	1.3	247	745	3.0
232	275	1.2	248	1005	4.1
251	260	1.0	286	835	2.9
263	280	1.1	301	900	3.0
265	265	1.0	343	1150	3.4
..	..	..	352	1260	3.6
..	..	..	360	1290	3.6
..	..	..	362	1095	3.0
..	..	..	381	1440	3.8
..	..	..	384	1475	3.8

It will be seen from the table, that on the whole the number of days and supposed distance increase evenly together, indicating that the drift-bottles have pursued almost the same route. Naturally we know nothing certain about the matter and differences perhaps indicate, that somewhat different routes have been followed, even if we exclude the possibility that some of the bottles have lain undiscovered for some time.

General Review of the 1929 Experiments.

At three places round Iceland, at Selvogsbanki on the south coast, Látrabjarg on the west coast and off Seydisfjord on the east coast, 300 drift-bottles were thrown out during 1929; of these only 24 or 8 per cent. have been recovered. The three experiments, however, have yielded very different results, the percentages of returned bottles being respectively 2, 3 and 19 per cent.

	No. of bottles	No. recovered	No. leaving Icelandic region
Experiment X	100	2	2
— XI	100	3	0
— XII	100	19	17
Total	300	24	19
Percentage	100	8.0	6.3

In contrast to the 1928 experiments by far the greater number of bottles have forsaken the Icelandic region; they have drifted away to Greenland, Ireland, the Faroes and Norway. The direction of drift, in the case of those which did not leave the Icelandic region, has been the well-known anticyclonic circulation round the island; from the East Icelandic district a couple have drifted westwards along the south coast and thus passed from one current system into another.

Of the bottles recovered outside the Icelandic region 2 have entered the Irminger Current; one of these passed into the East Greenland Current and thus displays the possibility of a direct connection between Selvogsbanki on the south coast of Iceland and South-West Greenland. A drift-bottle can pass from the water masses of one current system into those of another, and so can probably the young of fishes. At the same time, since the speed of drift is fairly considerable (6.1), this means that for example the fry of the cod might be carried the approximately 300 miles from Iceland to the east coast of Greenland in less than 50 days. Here at Angmagssalik quite a considerable stock of cod has been found in recent years. Apart from the immigration of adult individuals and their spawning at the spot we see here the possibility of the stock being recruited by postlarval stages coming from Iceland (perhaps with some years interval). In the transport of postlarval fish in this region it is worth noting, that they are carried from warmer to colder water, which means that their development until they reach the bottomstage is slowed down and prolonged. The opposite condition, transport from colder to warmer conditions, will act on the other hand as a hindrance to the transport of fry over great distances (e.g. from East Iceland to the Faroes).

The transport of a drift-bottle from the coastal banks of Iceland to Greenland has not hitherto been reported, but a drift-bottle thrown overboard about 70 miles south-west of Iceland has been recovered in the Belle Isle Straits (America) — see Nautisk-meteor. Aarbog, 1925, p. LX — and this must have gone there by way of the East Greenland current and the Labrador current.

Another drift-bottle from Selvogsbanki has not entered the East Greenland Current but has by way of the North Atlantic current reached Ireland (cf. experiments in 1928).

The great majority of the 1929 drift-bottles, however, have gone from the east coast across to the Faroes and Norway. Some contrast to the 1928 experiment from the east coast, which was made about the beginning of June, may be discerned in the probability that the 1929 drift-bottles, thrown out early in March, have passed closer to or over the Faroe Area. We may also note here, that the experiments of the "Islands Falk", made in August 1919 north-east of Iceland (Nautisk-meteor. Aarbog 1925), show

a greater average rate of drift per diem than that found in the present experiment; further, many of the drift-bottles from the "Islands Falk" pursued a route to or past the Shetlands, from which we have not received a single one. It is clear, therefore, that the current conditions in the region must have been very different in the years mentioned and, so far as the region north of Scotland and over towards the Faroes is concerned, this variability can readily be seen from an examination of the available data, from T. Wemyss Fulton's classical work of 1897[1]) right to the most recent hydrographical investigations.

When the drift-bottles have passed beyond the Faroes, their rate of drift with the current towards the north-east obviously increases to a considerable extent, as appears clearly from the foregoing summaries (p. 13). The average rate from Iceland to the Faroes is 1.0—2.6 miles per diem, whereas from Iceland to Norway (probably by way of the Faroes) it amounts to 2.9—4.1 miles per diem.

The great difference in time between drift-bottle 503 of experiment No. XII and the following (97 days against 208—265 days, see p. 13) would indicate, that the last have circulated for a long period in the region between Iceland and the Faroes, whilst the former has gone by a more direct route; however, as the bottle with rapid drift was recovered from the sea north of the Faroes, it is possible that the bottles otherwise may often tarry in the water in over the Faroese coastal banks for a long time before they are eventually carried to the land or away from there.

C. Results of the Experiments.

In *1928* drift-bottles to the number of *280* were thrown out at 9 places on all the coasts of Iceland; 50 or ca. 18 per cent. have been recovered. In *1929 300* were thrown out on the east, south and west coasts of Iceland; of these only 24 or 8 per cent. have been recovered (up to 1st February 1931). The number of bottles recovered is extremely diverse for the different places, from 0—ca. 29 per cent. For both years taken together only 13 per cent. have been recovered. The recoveries are thus lower than in the experiments recorded by Ryder 1901 and 1904, by J. N. Nielsen 1908 and by Anon. 1925; these experiments yielded from 23—61 per cent. of returns. The reasons for this difference may be of various kinds, but one of them may certainly be taken to be, that a fairly large number of bottles are lost on the rocky coasts of Iceland, whilst others are lost in the East Greenland current. The drift-bottles were not protected in any special way as was the case in some of the earlier experiments (Wandel, Nielsen).

In the *1928* experiments 14 or 5 per cent. left the Icelandic region and reached the Faroes, Ireland, Scotland and Norway. In 1929 the same thing happened with 19 or 6.3 per cent., which drifted to Greenland, Ireland, the Faroes and Norway.

At Iceland itself the drift has followed in the main the well-known anticyclonic

[1]) The currents of the North Sea and their relation to the fisheries. 15th Ann. Rep. Fishery Board for Scotland. Part III. 1896 (1897).

movement of the currents round the island. To the west and south-east a number of drift-bottles leave the Icelandic region and are carried away by the large current systems west—south-west and east—south-east of Iceland.

The experiments on the west and north-west coasts of Iceland lead to the conclusion, that the greater number of the bottles travelled westwards in the years under investigation; as they were not specially protected, one may suppose that their travels in great measure came to an end in the ice masses of the East Greenland polar current. From the south-west coast of Greenland the recovery of a single bottle has been reported, indicating that floating objects may be carried from the fishing banks of the Icelandic south coast to the west coast of Greenland (by way of the Irminger Current and the East Greenland current); the speed of the current is here somewhat considerable and additions to certain portions of Greenland's marine fauna may take place in this way from Iceland, if not every year yet in certain favourable periods.

Ireland and Scotland, as in earlier experiments, have received some of the drift-bottles from South Iceland, transported by the great current system south-west of Iceland. One of these bottles has travelled farther, over to Norway, with the Atlantic water-masses. The bottles which join in this current system leave Iceland at the south-west corner or some other places at the West coast.

The drift away from Iceland tends, however, chiefly towards the south-east, by which means a large number of bottles, especially from the east coast but also from the north coast, reach the Faroes and Norway by way of the East Iceland polar current and the Atlantic current. None of the bottles from these experiments has been recovered from the Shetlands, though several were found there in the earlier experiments; this confirms the difference already known which the course of the current can show from year to year.

The 1929 experiments, which were begun early in March, display a much greater drift of the bottles to the Faroes than those begun in June (1928), a result that may be ascribed to the variable strength of the East Icelandic and Atlantic currents at different periods of the year.

In Norway the drift-bottles have for the most part been driven on to the coast between the Trondhjem Fjord district and Varanger Fjord to the north.

The speed of the drift over the longer distances lies usually between 1 and 4 miles per diem; in waters near the Icelandic coast the rate may rise to about 8 or more, but the observations are too few and uncertain to add anything to what is already known from these waters. The speed during the transport from the east coast of Iceland to the Faroes is obviously lower than it becomes later in the Atlantic current from the Faroes to and along the coasts of Norway. The speed from south-west Iceland to the west coast of Greenland is rather high (abt. 6 miles per diem).

Apart from the fact, that the drift-bottles in certain parts of the region have pursued the same course as the prevailing westerly and south-westerly winds, it is only exceptionally that the influence of winds on the drift can be seen in these experiments.

1928.

Experiment No. I (bottles No. 1—25). Number of bottles: 25.

Liberation: Position: 63°09′ N. 19°00′ W. Locality: off Portland. Date: $^{14}/_{4}$ 1928. 10^{30} pm.

Recovery.

No. of bottle	Locality	Position (approximate) Lat. N.	Long.	Date and Year	No. of days adrift	Supposed distance of drift in miles	Average rate of drift per diem in miles
4	Western shore of Loch Erribol, Scotland	58°30′	4°40′ W.	$^{25}/_{7}$ 1930	832	1980	2.4
5	Miðnesi, Gullbringasysla	63°57′	22°42′ W.	$^{18}/_{5}$ 1928	34	117	3.4
6	Miðnesi, Gullbringasysla	63°57′	22°42′ W.	$^{15}/_{5}$ 1928	31	117	3.6
11	Svinöy, Sör-Heröy, Helgeland, Norway	66°00′	12°15′ E.	$^{5}/_{12}$ 1930	962	2550	2.7
15	Inishbofin, Co. Galway, Ireland	53°37′	10°13′ W.	$^{14}/_{10}$ 1930	910	1900	2.1
20	Off Faxe Bay	64°00′	23°40′ W.	$^{4}/_{5}$ 1928	20	140	7.0
21	Skerjafjörður, Faxe Bay	64°8′.9	22°0′.3 W.	$^{31}/_{5}$ 1928	47	147	3.1

Experiment No. II (bottles No. 26—50). Number of bottles: 25.

Liberation: Position: 63°41′ N. 22°02′ W. Locality: off Grindavík. Date: $^{15}/_{4}$ 1928. 0^{30} pm.

Recovery.

		N.	W.				
26	Off Grindavík	63°33′	22°05′	$^{19}/_{4}$ 1928	4	8	2.0
27	Off Grindavík	63°33′	22°05′	$^{19}/_{4}$ 1928	4	8	2.0
29	Portvoller, Stornoway, Scotland	58°13′	6°23′	$^{26}/_{7}$ 1930	833	1870	2.3
38	Near Kirkjuvogr, Gullbringasysla	63°55′	22°39′	$^{19}/_{5}$ 1928	34	27	0.8
47	Knararnes, Faxe Bay	64°2′	22°6′	$^{18}/_{5}$ 1928	33	62	1.9
50	Miðnesi, Gullbringasysla	63°57′	22°42′	$^{16}/_{5}$ 1928	31	31	1.0

Experiment No. III (bottles No. 51—75). Number of bottles: 25.

Liberation: Position: 64°40′ N. 23°53′ W. Locality: off Snæfellsnes. Date: $^{17}/_{4}$ 1928. 11^{30} pm.

Recovery.

		N.	W.				
53	1 mile NW. of Snæfellsnes Sandi	64°55′	23°53′	$^{21}/_{4}$ 1928	4	19	4.8
55	1 mile N. of Øndverðarnesi	64°54′	24°3′	$^{19}/_{4}$ 1928	2	14	7.0
62	2 miles W. of Snæfellsnes Sandi	64°55′	23°56′	$^{20}/_{4}$ 1928	3	17	5.7
70	2 miles N. of Øndverðarnesi	64°55′	24°3′	$^{19}/_{4}$ 1928	2	15	7.5

Experiment No. IV (bottles No. 76—100). Number of bottles: 24.

Liberation: Position: 65°31′ N. 24°37′ W. Locality: off Látrabjarg. Date: $^{18}/_{4}$ 1928. 4^{00} am.

Recovery.

No. of bottle	Locality	Position (approximate) Lat.	Long.	Date and Year	No. of days adrift	Supposed distance of drift in miles	Average rate of drift per diem in miles
nil.	..	..		..	..	..	..

Experiment No. V (bottles No. 101—125). Number of bottles: 25.

Liberation: Position: 66°31′ N. 22°28′ W. Locality: off Cape North. Date: $^{18}/_{4}$ 1928. 11^{00} pm.

Recovery.

		N.	W.				
103	Höfn, Havnvík (Cape North)	66°25′.5	22°30′	$^{4}/_{5}$ 1928	16	5	0.3

Experiment No. VI (bottles No. 251—300). Number of bottles: 47.

Liberation: Position: 66°28′ N. 22°23′ W. Locality: off Cape North. Date: $^{30}/_{5}$ 1928. 11^{30} pm.

Recovery.

		N.	W.				
255	Barðsvík, Strandasysla	66°20′.5	22°15′	$^{8}/_{9}$ 1928	101	9	0.1
276	Kollafjarðarnes, Strandasysla	65°36′.5	21°24′	$^{21}/_{6}$ 1928	22	61	2.8
286	Eyri, Ingolfsfjörður, Strandasysla ..	66°01′.5	21°39′	$^{20}/_{6}$ 1928	21	34	1.6
289	Árnes, Hunaflóa, Strandasysla	66°01′	21°31′	$^{10}/_{6}$ 1928	11	36	3.3
290	Ófeigsfjörður, Strandasysla	66°03′.5	21°44′	$^{17}/_{6}$ 1928	18	31	1.7
291	Broddanes, Strandasysla.....	65°36′	21°22′	$^{15}/_{6}$ 1928	16	64	4.0

Experiment No. VII (bottles No. 126—150). Number of bottles: 23.

Liberation: Position: 66°16′ N. 20°01′ W. Locality: off Skagi. Date: $^{19}/_{4}$ 1928. 3^{30} am.

Recovery.

		N.	W.				
136	Axarfjörður	66°10′	16°40′	$^{25}/_{6}$ 1928	67	82	1.2
146	Skjálfandi Bay, western shore	66°05′	17°43′	$^{25}/_{6}$ 1928	67	60	0.9
147	Bitrufjörður, Hunaflóa	65°28′	21°22′	$^{15}/_{6}$ 1928	57	63	1.1
149	Ósum, Vatnsnes, eastern shore, Hunaflóa	65°36′	20°36′	$^{10}/_{5}$ 1928	21	68	3.2

Experiment No. VIII (bottles No. 151—200). Number of bottles: 45.

Liberation: Position: 66°15′ N. 19°18′ W. Locality: N.W. of Siglunes. Date: $^{31}/_{5}$ 1928. 5^{15} am.

Recovery.

No. of bottle	Locality	Position (approximate) Lat. N. Long.	Date and Year	No. of days adrift	Supposed distance of drift in miles	Average rate of drift per diem in miles
152	Kjænningvik, Kobbefjord, Vestfinmarken, Norway	70°50′ 25°15′ E.	$^{15}/_{4}$ 1929	319	1400	4.4
154	Naustavík (Hellunes) Eyjafirði	65°57′ 18°23′ W.	$^{20}/_{6}$ 1928	20	32	1.6
155	Between Ólafsfj. og Hjedinsfj. abt. 1 mile off the coast	66°09′ 18°35′ W.	$^{1}/_{6}$ 1928	abt. 2	19	9.5?
174	Sörvær i Tjötta, Helgeland, Norway	65°45′ 12°23′ E.	$^{22}/_{3}$ 1929	295	960	3.2
176	Between Ólafsfj. og Hjedinsfj. abt. 1 mile off the coast	66°09′ 18°35′ W.	$^{1}/_{6}$ 1928	abt. 2	19	9.5?
180	Kobbefjord, Maasöy Sogn, Vestfinmarken, Norway	70°50′ 25°15′ E.	$^{12}/_{6}$ 1929	377	1400	3.7
183	Dalvík, Eyjafirði	65°58′ 18°31′ W.	$^{17}/_{6}$ 1928	17	31	1.8
184	Between Ólafsfj. og Hjedinsfj. abt. 1 mile off the coast	66°09′ 18°35′ W.	$^{1}/_{6}$ 1928	abt. 2	19	9.5?
189	Between Ólafsfj. og Hjedinsfj. abt. 1 mile off the coast	66°09′ 18°35′ W.	$^{1}/_{6}$ 1928	abt. 2	19	9.5?
190	Oddeyri, Akureyri	65°41′ 18°05′ W.	$^{8}/_{6}$ 1928	8	50	6.3
191	Eyjafirði, SW. of Hrisey	65°58′ 18°24′ W.	$^{5}/_{6}$ 1928	5	32	6.4
192	Dalvík, Eyjafirði	65°58′ 18°31′ W.	$^{6}/_{6}$ 1928	6	31	5.2
196	Eastern part of entrance to Eyjafirði	66°10′ 18°22′ W	$^{4}/_{6}$ 1928	4	30	7.5

Experiment No. IX (bottles No. 201—250). Number of bottles: 41.

Liberation: Position: 65°11′.5 N. 13°23′.5 W. Locality: off Horn (East-Iceland). Date: $^{27}/_{6}$ 1928. 0^{20} pm.

Recovery.

		N.				
213	Hennes, Hadsel, Nordland, Norway	68°32′.5 15°13′ E.	$^{23}/_{3}$ 1929	269	970	3.6
219	Kalsöfjord, Faroe, $^{1}/_{2}$ mile off the coast	62°15′.2 6°39′.3 W.	$^{15}/_{11}$ 1928	141	260	1.8
223	Söröy, western shore, abt. 4 miles north of Hasvik; Vestfinmarken, Norway	70°32′ 22°15′ E.	$^{21}/_{1}$ 1929	209	1170	5.6
225	Hjörleifshöfdafjara, Myrdalssand	63°24′ 18°48′ W.	$^{23}/_{8}$ 1928	57	192	3.4
230	Ersfjord, Tromsö Fylke, Norway	69°42′ 18°25′ E.	$^{10}/_{1}$ 1929	198	1070	5.4
234	Torsvaag, Tromsö, Norway	70°15′ 19°32′ E.	$^{8}/_{11}$ 1929	499	1110	2.2
235	Vaagsöy, 24 miles north of Tromsö, Norway	about 70°05′ 18°40′ E.	$^{19}/_{4}$ 1929	296	1090	3.7
237	Kvitnæs, Vesteraalen, Norway	68°35′ 15°10′ E.	$^{13}/_{8}$ 1929	412	970	2.4
239	Papey, Djupivogur	64°36′ 14°8′ W.	$^{8}/_{7}$ 1928	11	41	3.7

1929.

Experiment No. X (bottles No. 301—400). Number of bottles: 100.

Liberation: Position: 63°34′.5 N. 21°03′.5 W. Locality: Selvogsbanki. Date: $^{14}/_{2}$ 1929. 10^{05} am.

Recovery.

No. of bottle	Locality	Position (approximate) Lat. N.	Long. W.	Date and Year	No. of days adrift	Supposed distance of drift in miles	Average rate of drift per diem in miles
301	Sydprøven, Julianehaab, Greenland	60°28′	45°29′	$^{27}/_{6}$ 1929	133	810	6.1
394	Between Malin Head and Innishowen Head, Co. Donegal, Ireland.....	55°18′	7°6′	$^{1}/_{10}$ 1930	594	1920	3.2

Experiment No. XI (bottles No. 401—500). Number of bottles: 100.

Liberation: Position: 65°22′ N. 24°25′ W. Locality: off Látrabjarg. Date: $^{22}/_{2}$ 1929. 11^{25} am.

Recovery.

		N.	W.				
407	5 miles east of Fjallahöfn, Axarfirði.	66°8′.5	16°45′	$^{19}/_{6}$ 1929	117	262	2.2
450	Anchorage, Flatey, North-Iceland....	66°9′	17°52′	$^{30}/_{4}$ 1929	67	237	3.5
471	East of Cape North, off Drifandisfoss	66°23′	22°19′	$^{15}/_{7}$ 1929	143	102	0.7

Experiment No. XII (bottles No. 501—600). Number of bottles: 100.

Liberation: Position: 65°16′ N. 13°23′ W. Locality: off Seydisfjord. Date: $^{8}/_{3}$ 1929. 1^{10} pm.

Recovery.

		N.					
503	Off Faroes.....	62°15′	7°42′ W.	$^{13}/_{6}$ 1929	97	250	2.6
507	Stafnes (Reykjanes).....	63°58′	22°45′ W.	$^{8}/_{6}$ 1929	92	315	3.4
510	Stopperfjord, Rolfsöy, Vestfinmarken, Norway.....	70°58′	24°00′ E.	$^{3}/_{3}$ 1930	360	1290	3.6
511	Hestö, Faroe.....	61°57′	6°52′ W.	$^{2}/_{10}$ 1929	208	270	1.3
519	Vestmanhavn, southern shore, Faroe	62°09′	7°10′ W.	$^{28}/_{11}$ 1929	265	265	1.0
535	Sessöy, Hillesöy, Troms Fylke, Norway.....	69°45′	18°12′ E.	$^{14}/_{2}$ 1930	343	1150	3.4
537	Bleik, Vesteraalen, Norway	69°16′	15°55′ E.	$^{5}/_{3}$ 1930	362	1095	3.0
541	Off Trondhjemsfj., Norway.....	63°49′	8°37′ E.	$^{10}/_{11}$ 1929	247	745	3.0
544	Havningberg (harbour), Finmarken, Norway.....	70°30′	30°38′ E.	$^{24}/_{3}$ 1930	381	1440	3.8
555	Kalbaksfjord, Faroe.....	62°03′	6°49′ W.	$^{26}/_{11}$ 1929	263	280	1.1
557	Galten, Söröy, Vestfinmarken, Norway.....	70°45′	22°42′ E.	$^{23}/_{2}$ 1930	352	1260	3.6
562	Sandvig, Faroe	61°38′	6°55′ W.	$^{26}/_{10}$ 1929	232	275	1.2
569	Off Faroe.....	62°6′	7°28′ W.	$^{14}/_{11}$ 1929	251	260	1.0
574	Krampenes, Nordvaranger, Norway.	70°12′	30°30′ E.	$^{27}/_{3}$ 1930	384	1475	3.8
581	Stjerndahl Sund, Lofoten, Norway..	68°00′	13°10′ E.	$^{11}/_{11}$ 1929	248	1005	4.1
583	Wikna, Namdal, Norway.....	64°53′	11°05′ E.	$^{19}/_{12}$ 1929	286	835	2.9
595	Syðri Steinsmyrarfjara, Medalland...	63°39′	17°48′ W.	$^{15}/_{6}$ 1929	99	166	1.7
596	Tranöy, Sörsmöla, Norway	63°20′	7°58′ E.	$^{30}/_{9}$ 1929	191	720	3.8
600	Hjelmsöy, Helgeland, Norway	65°59′	12°25′ E.	$^{3}/_{1}$ 1930	301	900	3.0